









SMITHSONIAN INSTITUTION  
UNITED STATES NATIONAL MUSEUM

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## ADVERTISEMENT

The scientific publications of the National Museum include two series, known, respectively, as *Proceedings* and *Bulletin*.

The *Proceedings*, begun in 1878, are intended primarily as a medium for the publication of original papers, based on the collections of the National Museum, that set forth newly acquired facts in biology, anthropology, and geology, with descriptions of new forms and revisions of limited groups. Copies of each paper, in pamphlet form, are distributed as published to libraries and scientific organizations and to specialists and others interested in the different subjects.

The dates at which these separate papers are published are recorded in the tables of contents of each of the volumes.

The present volume is the hundred and sixth of this series.

The *Bulletin*, the first of which was issued in 1875, consists of a series of separate publications comprising monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, catalogs of type specimens, special collections, and other material of similar nature. The majority of the volumes are octavo in size, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable. In the *Bulletin* series appear volumes under the heading *Contributions from the United States National Herbarium*, in octavo form, published by the National Museum since 1902, which contain papers relating to the botanical collections of the Museum.

REMINGTON KELLOGG,  
*Director, United States National Museum.*



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<sup>1</sup> Erratum: On page 508, line 7, for "*Arycanthis*" read "*Arvicanthis*."



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## REVISION OF THE MILLIPED GENUS DIXIORIA (POLYDESMIDA: XYSTODESMIDAE)

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By RICHARD L. HOFFMAN

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Generally speaking, most of the published work on the classification of the diplopods has been either fragmentary or carelessly superficial, often both. This is particularly true in the United States where, except for the valuable work of O. F. Cook and H. F. Loomis, there is only a welter of short papers on millipeds that contain brief and in many cases meaningless descriptions of miscellaneous new forms.

The prevailing method of treatment apparently has discouraged a number of interested students who have found the confusion too great to overcome. I feel that the time is long overdue for some attempt to assemble and evaluate our present knowledge, and to present it in a form that will be useful to others.

I have undertaken the preparation of formal taxonomic revisions of certain North American milliped groups, to be published as available material permits in the form of revisions of genera. Each paper is intended to be as thorough as possible with the material at hand, and in some cases the results compare favorably with published studies of many vertebrate groups. The family Xystodesmidae is selected as a starting point because it is rich in genera and species as well as

in individuals; because of the localization of most species which enhances their value in evolutionary studies; and because of the relative ease of obtaining specimens for study. This last factor is particularly true in the case of those genera confined to the Southern Appalachians.

The present study is devoted to *Dixioria*, a small genus of attractively colored diplopods which is restricted to the Southern Appalachians in western North Carolina, eastern Tennessee, and southwestern Virginia. Occurring in a very deeply dissected mountain region, the forms of *Dixioria* are quite localized and afford interesting material for the study of distribution and phylogeny.

My original plan to revise all of the xystodesmid genera in a single publication has been abandoned, as it became obvious that such an endeavor would necessarily be postponed for many years. It seemed best to reserve a general treatment of generic relationships and evolution to serve as a culmination, rather than initiation, of the series.

#### MATERIALS AND METHODS

For this study I have examined approximately 100 specimens, representing all of the seven recognized forms of *Dixioria* and including the type specimens of the two previously named species. Five additional names are proposed herein. I have personally collected material of all of the forms except *Dixioria pela brooksi* and *D. dactylifera*, and this field experience has been particularly useful in providing first-hand knowledge of the physiographic factors influencing distribution.

Most of the specimens have been collected by me or by friends, but additional material has been examined from the collections of several museums. Abbreviations used in the text to designate the sources of preserved study specimens are as follows:

AMNH, American Museum of Natural History, New York, N. Y.

CM, Carnegie Museum, Pittsburgh, Pa.

MCZ, Museum of Comparative Zoology, Cambridge, Mass.

RLH, Private collection of R. L. Hoffman, Blacksburg, Va.

USNM, United States National Museum, Washington, D. C.

The drawings were made from gonopods immersed in alcohol, using a binocular microscope equipped with an ocular grid. This attachment facilitated very accurate transfer of the image to coordinate paper, and also made possible careful comparison of gonopods with previous illustrations.

Extreme care was taken to orient the gonopods into a uniform position for drawing, so that fictitious differences in appearance arising from different aspects might be kept to a minimum. Failure to take

such an elementary precaution has been one of the outstanding defects of American diplopod taxonomy.

For the privilege of studying the collections under their care, I am indebted to Dr. E. A. Chapin, formerly of the U. S. National Museum, Dr. Willis J. Gertsch of the American Museum of Natural History, and Dr. P. J. Darlington of the Museum of Comparative Zoology. Gordon K. MacMillan kindly loaned all of the Appalachian millipeds in the Carnegie Museum, including several interesting series of different forms.

Most of my field work was done with the aid of grants from the Virginia Academy of Sciences and the Highlands (North Carolina) Biological Station. James A. Fowler, Hubert I. Kleinpeter, and William T. Keeton have been helpful companions in the field.

More than to anyone else, this study of *Dixioria* owes its existence to my good friend Leslie Hubricht, an outstanding student of American gastropods and an unexcelled collector, who has provided perhaps the largest part of the material in my collection.

#### REVIEW OF THE LITERATURE

A certain amount of confusion presently attends usage of the generic names *Deltotaria* and *Dixioria*. I have personally contributed to this misunderstanding, and am glad to take the opportunity to review the status of the two groups with the hope of correcting previous mistakes.

The genus *Deltotaria* was proposed by Causey in 1942 for the reception of a new species (*brimleii*) collected at Swannanoa, N. C. The primary diagnostic character cited for the genus was the presence of a projection on the coxal joint of the gonopod. Somewhat later, two additional species were described, *D. nigrimontis* (Chamberlin, 1947) and *D. coronata* (Hoffman, 1949). Apparently both Chamberlin and I were impressed by the fact that the distal end of the gonopod in our species was similar to that figured for *brimleii* (furcate), and we overlooked the complete absence of a coxal projection in our new forms. With the initiation of intensive studies on the genera of the Xystodesmidae, it became apparent that members of two considerably different genera had been described under the name *Deltotaria*. More recently, Dr. Causey published the descriptions of two additional species, both of which agree with the generotype, thus emphasizing the misplacement of *coronata* and *nigrimontis*.

At first it appeared that a new generic name was needed to embrace these two orphaned species, which seemed to fit into none of the currently recognized genera. Soon, however, I discovered that *Dixioria* of Chamberlin (1947) was available for one of them because its type species is subjectively congeneric with *coronata*, and that the other is

referable to the genus *Sigmoria*, as will be shown in a later paper of this series.

*Fontaria pela* was described by Chamberlin (1918) from material collected at Burbank, Tenn. The original description did not contain drawings of the gonopods, and the species, more or less unidentifiable, dropped into obscurity for the next 30 years. In 1947, Chamberlin described another new species as *Dixioria dentifer*, the type locality of which is Cranberry, N. C. Less than two years later, in February 1949, I examined the type of *Fontaria pela* at the Museum of Comparative Zoology and discovered that *pela* and *dentifer* are names based upon the same species. *Dixioria*, therefore, becomes the proper name for *Fontaria pela* as well as for my *Deltotaria coronata*. Although there are considerable differences between the original drawings of the gonopods of *coronata* and *dentifer*, I believe that the illustrations in this paper will establish that the two are congeneric. The discovery of intermediate forms also serves to corroborate this relationship.

#### TAXONOMIC CHARACTERS

The structural peculiarities which characterize the genus *Dixioria* are fairly numerous and distinctive. The most obvious is the color pattern, there being no other genera in the eastern United States in which the dorsum is black with the caudolateral half of the paranota, tip of the telson, and anterior edge of the collum bright yellow. Because of this peculiarity, females as well as males can be placed into *Dixioria* with confidence. However, since the pattern is identical in all of the known forms, it is of no utility in separating species.

Another generically diagnostic character is the configuration of the paranota, of which both anterior and posterior corners are broadly rounded on all except the last few segments. Among other xystodesmids of eastern North America, this feature is duplicated only in some forms of *Brachoria*, all of which are considerably wider in proportion to their length than of the relatively slender species of *Dixioria*.

The gonopods of the male sex, while varying considerably in small details, preserve an over-all similarity throughout the genus and are distinctive from those of other known genera. The prefemoral process is always present and conspicuous, in the form of a wedge-shaped, usually slender, upright peg. The telopodite blade is very slender and unmodified except at its distal end, forming an even curve similar to that found in the genus *Apheloria*. Distally the telopodite is enlarged and provided with one or two subterminal processes of variable size but usually thin and laminate in shape. None of these serves as a solenomerite, as the seminal groove continues on to the tip of the telopodite proper.



So little is yet known of the comparative morphology of the cyphopods in most milliped groups that little can be said of their value in the differentiation of genera. It seems, at present, that the cyphopods do not differ markedly from those of *Brachoria* and of the Trimaculata group of *Apheloria*, although more detailed studies may reveal the presence of very distinct features.

Structural differences used in the separation of the forms of *Dixioria* are of two kinds. Most conspicuous, and perhaps most fundamental, are the differences in the shape of the male gonopods, and these are the features customarily utilized by most students of the Diplopoda.

During the course of my studies of polydesmoid millipeds, however, I have found that in most cases where the gonopods are singular enough to indicate specific distinction, a close examination of the material will reveal other correlated structural peculiarities. It is my belief that, generally speaking, if a species is actually a valid one it can be distinguished from its congeners by characters other than those expressed by the male genitalia.

In the present instance, *Dixioria pela* is separable from *D. dactylifera* by several tangible characters aside from the obviously disjunct gonopods. These differences may be described verbally and are mentioned both in the following key to species and in the diagnosis of *D. dactylifera*. They are of interest in several respects.

First, they serve to indicate that perfectly good taxonomic characters may be disregarded in the general preoccupation with male genitalia and color pattern—two variables which seem to have claimed the attention of most American workers. Second, the discovery that coxal spines may be present in one species and absent from another suggests that their utilization in generic diagnosis may have to be somewhat modified as our knowledge of variability of the character improves. Heretofore, the presence or absence of coxal spines has been considered to be constant in a genus.

Despite the six or seven respects in which the two species of *Dixioria* differ superficially, their general similarity in structure, color pattern, size, and appearance is so great as to preclude any doubt of the homogeneity of *Dixioria* as a generic entity.

Taxonomic differences expressed by the gonopods of the male are, to a considerable extent, qualitative and best appreciated by reference to drawings. Nonetheless, it is quite possible to distinguish and describe some of these differences verbally, and, with the development of homologies and a terminology for the parts, to abolish the old ambiguous phrase, "Gonopods as illustrated." In treating the gonopod characters in *Dixioria*, particular attention is here given to the distal end of the telopodite, with its teeth and lobes, and to the shape of the prefemoral process.

An outstanding characteristic of the genus is the presence of a small, very thin, triangular tooth (referred to as process A) near the end of the telopodite. All of the subspecies of *pela* are provided with this feature. In most of them there is also an expansion of the end of the telopodite and a supplementary oblong lobe, or process (referred to as process B). In the case of *dactylifera*, process B has become unusually enlarged, and A has disappeared entirely. In this instance, and also in those subspecies of *pela* where B is enlarged, it is useful to distinguish the true ending of the telopodite with the term solenomere (S). Possibly the name parsolenomere might be adopted to replace "process B," but I hesitate to devise a terminology until homologies have been worked out for all the genera of the family.

One may observe some geographic variation in the gonopods of the forms of *Dixiora pela*. There is a trend from south (*pela*) to north (*fowleri*) toward increase in the size of the prefemoral process and a corresponding decrease in the length and arch of the telopodite blade. A similar variation occurs, altitudinally, in a reverse direction in that *coronata* (presumably a montane derivative of *fowleri*) shows tendencies back toward the characters of *pela*.

The average size of series varies considerably and at first suggested itself as a secondary taxonomic difference. However, this varies within subspecies as well as between them, and I conclude that dimension is a character which varies at least with the individual and at most with any given micropopulation. It may be only a reflection of propitious environmental conditions.

Various other characters, such as the shape of the paranota of the caudalmost segments, were considered for their possible utility in separating subspecies. Several variations, which at first appeared to be useful, were found to break down when series of specimens were checked, and in general it seems that such qualitative differences, even if stable, are so slight that they would be negated by the normal amount of error inherent in making drawings under low magnification.

### Genus *Dixiora* Chamberlin

*Dixiora* Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 28, 1947.

*Deltotaria* (not Causey) Hoffman, Proc. U. S. Nat. Mus., vol. 99, p. 379 (in part), 1949.

TYPE SPECIES: *Dixiora dentifer* Chamberlin 1947 (= *Fontaria pela* Chamberlin 1918), by original designation.

DIAGNOSIS: A fontariid genus characterized as follows: prefemora of legs with a sharp distal spine, coxae with or without small ventral spines; sternites without obvious processes at bases of legs and not produced on caudal margin; tergites smooth, paranota rather small,

with both corners rounded on most segments, pores opening dorso-laterally.

Male gonopod rather simple; no coxal process, prefemoral portion globosely swollen and with an erect, somewhat cuneiform process, remainder of telopodite a slender, unmodified, strongly curved blade, with one or two small subterminal processes and occasional subterminal enlargement. Coxae separate from each other but connected by a strong band of sclerotized tissue.

Size of animals moderate, from 30 to 40 mm. in length, rather slender, width about 20 percent of length. Dorsum black, with caudolateral corners of paranota and anterior margin of collum bright lemon yellow, legs and other ventral surfaces yellowish tan to light brown.

RANGE: Southern Appalachian Mountains, specifically in and adjacent to the Iron-Unaka mountain chain, from Bland County, Va., south to Grandfather Mountain, N. C., and Roan Mountain, Tenn. In general, the ranges in distribution of each form coincide closely with separate mountains or mountain ranges.

SPECIES: Two, one of which is divided into six subspecies.

### Key to the known forms of *Dixioria*

1. Coxal spines absent or represented only as a faint remnant on some of the caudalmost legs; all sternites with at least 8 setae; gonopod socket extending laterad past outer end of coxal acetabula; process A of gonopods absent, process B greatly enlarged . . . . . **dactylifera**  
Coxal spines present, conspicuous; most of the sternites glabrous, a few with up to 8 or 10 setae; gonopod aperture not extending laterad past coxal acetabula; process A of gonopods present, process B variable . . . . . 2
2. Distal end of telopodite of male gonopod with only one subterminal process (A) . . . . . 3  
Distal end of telopodite of male gonopod with two subterminal processes (A and B) . . . . . 4
3. Telopodite gradually tapering distad; distal end of prefemoral process bent lateral at a right angle or nearly so . . . . . **pela pela**  
Telopodite conspicuously laminately expanded near end; prefemoral process straight or nearly so . . . . . **pela acuminata**
4. Distal end of telopodite noticeably capitate (enlarged on the outer margin), processes A and B more or less coalesced; telopodite rather flattened in cross section . . . . . **pela brooksi**  
Distal end of telopodite not especially capitate, its subterminal processes discrete; femoral portion subterete in cross section . . . . . 5
5. Process B very large, becoming larger and broadly truncate distally; prefemoral process bent at a right angle distally; solenomerite very long. . . . . **pela wrighti**  
Process B small, digitiform, only slightly larger than A; prefemoral process cuneiform, not bent distally . . . . . 6
6. Prefemoral process broader, with an obtuse lobe on its outer edge . **pela fowleri**  
Prefemoral process narrower, outer edge nearly straight but with a small subterminal indentation . . . . . **pela coronata**

*Dixioria pela pela* (Chamberlin)

## FIGURE 1,a

*Fontaria pela* Chamberlin, Psyche, vol. 25, p. 123, 1918.

*Dixioria dentifer* Chamberlin, 1947, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 28, fig. 13, 1947, (Cranberry, Avery County, N. C.; type in AMNH).

*Apheloria pela* Hoffman, in D. L. Wray, Insects of North Carolina, Second Supplement, p. 44, 1950.

TYPE SPECIMENS: Male holotype and paratypes of both sexes (MCZ), from Burbank, Carter County, Tenn., collected by Roland Thaxter.

DIAGNOSIS: Prefemoral process of male gonopod slender, upright, only slightly bent distally; telopodite with tip attenuated, very little expanded and modified only by the presence of a subterminal tooth (A); telopodite blade long and slender, somewhat sigmoidally curved distally.

DESCRIPTION: Given in full only for the typical subspecies since the others differ only in gonopod structure.

Length, 35 to 42 mm., width, 5.0 to 9.0 mm. Body relatively slender, parallel-sided, segments 4-16 essentially of full width. Width of body about 20 percent of length, varying from 19 to 22 percent.

Head smooth and shining, vertigial groove distinct and obviously punctate, genae slightly swollen near antennal concavity but not medially impressed. A single paramedian clypeal seta on each side, interantennal frontal setae and supra-antennal occipital setae absent. Antennae separated by a distance equal to length of 3d antennal article, moderately long, extending caudad to caudal margin of second tergite; articles 2-5 subequal in size and shape, approximately 1.2 mm. in length and distinctly clavate; 6th article slightly shorter and somewhat thicker; 7th short but distinct, with four sensory cones. Articles 1-4 sparingly setose, 5th slightly more so, 6th and 7th densely covered with short declivous setae.

Collum slightly wider than following tergite, its caudal margin completely straight across and the lateral ends broadly rounded; anterior margin straight across head, laterad of which it is swept back on each side and set off by a marginal groove. Surface perfectly smooth and shining except for a slightly impressed area near the front margin adjacent to the antennae in some specimens.

Tergites of succeeding segments essentially similar to each other, moderately arched and smooth. Paranota rather small, continuing slope of dorsum, their anterior and posterior corners broadly rounded off on all except the last four or five segments; anterior and lateral edges set off by distinct grooves but peritremata not distinct and pores opening almost laterally. Caudal edges of paranota sharp, not mar-

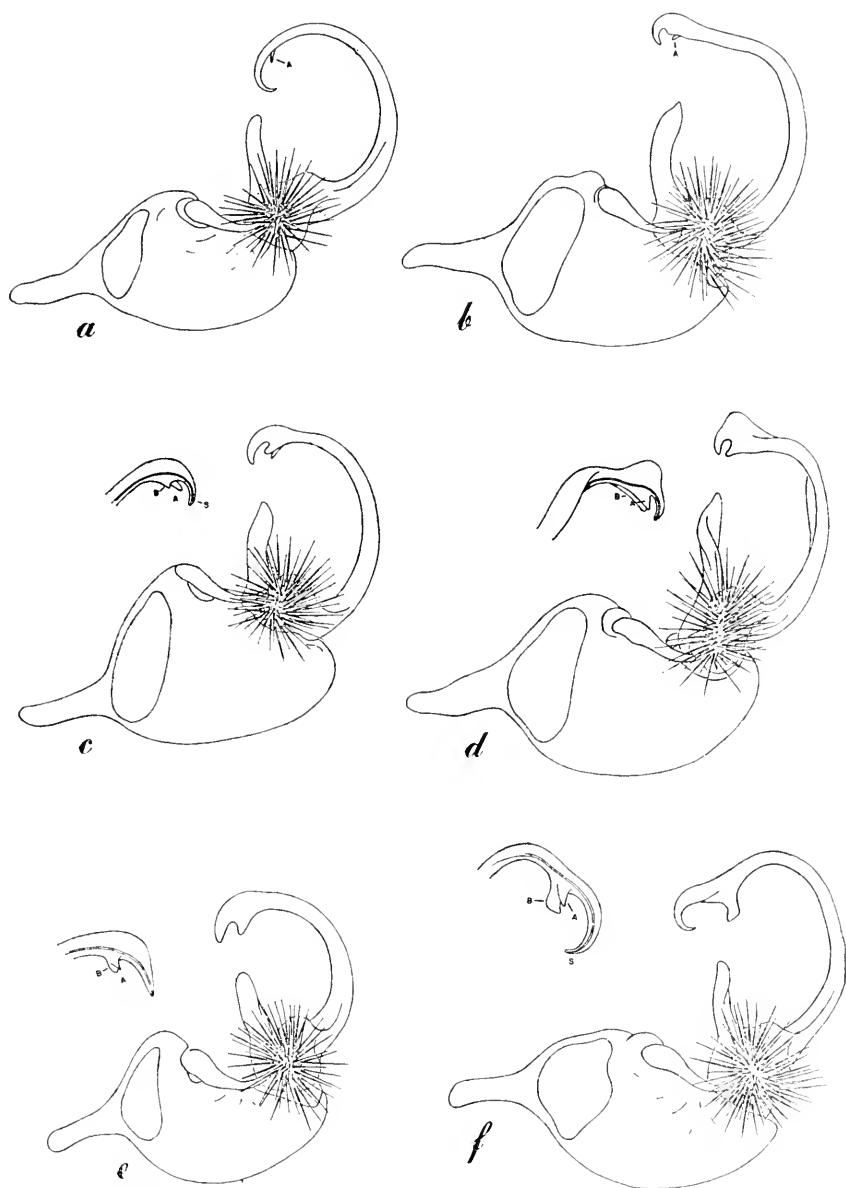


FIGURE 1.—Left male gonopods of the subspecies of *Dixioria pela*, mesial aspect. In most cases the lateral aspect of the end of the telopodite is also shown separately. *a*, *D. p. pela*; *b*, *D. p. acuminata*; *c*, *D. p. coronata*; *d*, *D. p. brooksi*; *e*, *D. p. fowleri*; *f*, *D. p. wrightii*.

gined; upper surface smooth with extremely faint longitudinal striations. Caudolateral corners of paranota caudal to 14th, becoming increasingly produced.

Median projection of anal segment subtriangular in dorsal aspect, longer than broad, the tip slightly truncate and bearing several long setae. Anal valves glabrous, the mesial margin of each produced into a low ridge but no other obvious sculpture. Preanal scale broadly triangular, wider than long, with a median and two smaller lateral, setiferous, tubercules.

Sternal areas of metazonites essentially flat or slightly concave, not raised above level of prozonite but set off by a broad, shallow, sharply defined interzonal furrow. Sternites slightly produced at base of each leg, becoming subspiniiform toward the rear of body. Sternites glabrous or at most with six or eight scattered setae on some of the segments just behind the gonopods. Coxae and prefemora with acute conical distoventral spines, these becoming longer caudad; these leg joints also with numerous long slender setae on the ventral side. Femora nearly glabrous, slightly clavate, shorter than coxae and prefemora combined. Postfemora and tibiae equal in length, the latter of a lesser diameter and about half as long as the moderately setose and subcylindrical tarsi. Tarsal claws of anterior legs of males long, sinuous, with a distinct sharp carina along the dorsal side.

Sternites between 3d legpair produced upward into two slender, digitiform lobes, those between 4th, 5th, and 6th legpairs in the form of low rounded eminences.

Pleurites coriaceous, somewhat obliquely longitudinally striate in some specimens, the caudal margin distinctly set off. No tubercules, granules, or clusters of spines.

Sternal aperture of 7th segment of males large, transversely oval, widest in front of the middle, strongly margined laterally and between the coxae of the 8th legpair.

Gonopods freely movable, the coxae separate and connected only by a strong band of connective tissue. In situ, the main axis of the telopodite blade lies at a right angle to that of the body, the gonopods at rest thus have the blades overlapping and often interlocked. Coxal apodeme moderately long, slightly enlarged distally. Coxae without special processes. Prefemur swollen, densely setose, with a prominent, upright, wedge-shaped prefemoral process. Telopodite blade slender, evenly curved into almost a complete circle, without trace of division into femur, tibia, and tarsus. Telopodite distally slightly expanded, with a small thin subtriangular tooth (process A).

Tergites glossy brownish black, with caudolateral two-thirds of the paranota, anterior edge of collum, and tip of anal segment bright lemon yellow. Underparts yellowish tan, somewhat burnished in

appearance. Head dark brown except for the lighter labral area; antennae light brown with distal portion of each article white. Tarsal claws brown, sternites darker than the legs. A faint dark spot in the yellow of the paranota just above each repugnatorial pore.

ECOLOGY: The only specimen of *Dixioria pela pela* that I have collected was found beneath a stone near the edge of a grassy field at Cloudland, on Roan Mountain, at an elevation of about 6,000 feet. It was associated with numerous specimens of the xystodesmid *Boraria media* (Chamberlin). I had previously searched at several places on the Tennessee side of Roan Mountain between 3,000 and 5,000 feet without success, but a week later, on June 27, Leslie Hubricht obtained a good series on the North Carolina side during night collecting for land snails.

This subspecies has perhaps the largest areal range of any member of the genus, and its vertical distribution is certainly not surpassed. The records encompass elevations ranging from about 2,000 feet up to 6,000 feet. The lowland material is not recognizably different in the genitalia.

DISTRIBUTION: *Dixioria p. pela* appears to be confined to the Unaka range in the immediate vicinity of Roan Mountain. The precise limits of its distribution are yet to be established, but I suspect that its southward occurrence is confined by the Nolichucky River, south of which I have collected at several localities without finding any form of *Dixioria*. It will be of interest to determine the area of intergradation between *pela* and *coronata*, which must lie in the eastern part of Johnson County, Tenn.

Distributional records and the specimens upon which they are based are as follows:

NORTH CAROLINA. Avery County: Cranberry, date and collector not known (AMNH, type of *dentifer* Chamberlin, probably intergrade with *D. p. wrighti*). Mitchell County: East side of Roan Mountain, 1 mile below Carver's Gap, Leslie Hubricht coll., June 27, 1950 (RLH).

TENNESSEE. Carter County: Burbank, Roland Thaxter, no date (MCZ, type series); 2 miles southeast of Burbank, Hubricht, Sept. 1, 1951 (RLH); Doe River Bluff, near Hampton, Hubricht, May 3, 1951 (RLH, a male with tendencies toward *acuminata*). Unicoi County: Iron Mountain Gap, 4 miles southeast of Limestone Cove, Hubricht, Sept. 2, 1951 (RLH).

#### *Dixioria pela acuminata*, new subspecies

##### FIGURE 1,b

TYPE SPECIMEN: Male holotype (USNM 2011), collected at the top of Holston Mountain 2 miles west of Shady Valley, Johnson County, Tenn., by J. A. Fowler and R. L. Hoffman on June 19, 1950.

DIAGNOSIS: Prefemoral process nearly straight, very slightly expanded distally, with a small terminal acuminate point. Distal



third of telopodite blade straight (not completing the curve of the basal two-thirds), having only process A, but the terminal portion somewhat enlarged with a very small lobe probably homologous to B.

ECOLOGY: The type and only known specimen was found in deep leaf mold in a rather dry oak-hickory woods. Collected at the same time and place were specimens of the millipeds *Ptyoiulus pennsylvanicus* (Brandt) and *Apheloria waccamana* Chamberlin, and the salamander *Plethodon yonahlossee* Dunn.

DISTRIBUTION: Known only from the type locality, and probably restricted to Holston Mountain, between Damascus, Va., and Elizabethton, Tenn.

*Dixioria pela brooksi*, new subspecies

FIGURE 1,*d*

TYPE SPECIMENS: Male holotype (USNM 2012), male and female topoparatypes (CM), collected on Holston Mountain at Damascus, Washington County, Va., by Dr. and Mrs. Stanley T. Brooks on Aug. 14, 1941.

DIAGNOSIS: Distinguished from the other subspecies by the curious lobelike distal enlargement of the tibiotarsus of the gonopod, producing a somewhat hammerheadlike shape. Notable also is the fact that processes A and B are more or less coalesced to form what appears with low magnification to be simply a notched process. The telopodite is somewhat flattened and is provided with a small lateral flange just distad to its midlength. The prefemoral process is nearly straight and distally acute.

ECOLOGY: I know nothing of the circumstances under which the type series was obtained. *D. brooksi* is doubtless a low-altitude form.

DISTRIBUTION: Known so far only from the type collection. What is most needed at this time is a very intensive study of the relationships of the *Dixioria* forms around Damascus. Within a 10-mile radius three forms, *coronata*, *fowleri*, and *brooksi*, have been obtained. The first two doubtless intergrade. But whether *brooksi* is really a subspecies of *pela* or a distinct species in itself cannot be guessed at the present.

*Dixioria pela coronata* (Hoffman)

FIGURE 1,*c*

*Deltotaria coronata* Hoffman, Proc. U. S. Nat. Mus., vol. 99, p. 380, pl. 26, figs. 7, 8, 1949.

TYPE SPECIMENS: Holotype, allotype, and paratype (USNM 1805); topoparatypes (MCZ); collected at Mount Rogers, Grayson County, Va., by H. I. Kleinpeter and R. L. Hoffman, June 30–July 1, 1947.

DIAGNOSIS: Distal end of telopodite of male gonopod somewhat expanded, with a large curved subterminal tooth (B) and a much smaller and thinner one adjacent to it on the outer side. The prefemoral process is nearly straight along its outer margin, which is subterminally notched or indented.

ECOLOGY: This seems to be an altitudinally restricted form. The altitudes of most places at which it has been taken exceed 3,000 feet. It occurs in hardwood and mixed forests, but not in the spruce-balsam stands which cover the tops of the Iron Mountains. More diurnal in habits than most xystodesmids (perhaps a function of its very moist habitat), *coronata* is often seen abroad during the day. A mated pair was found on July 1.

DISTRIBUTION: The Iron Mountains in Grayson and Washington Counties, Va., and Johnson County, Tenn. Its northern limits are probably reached just north of Mount Rogers, but just how far it goes into Tennessee along the Iron Mountains remains to be determined.

Distributional records and the specimens upon which they are based are as follows:

VIRGINIA. Grayson County: East side of Mount Rogers, 5,000 feet, Kleinpeter and Hoffman, June 30, 1947 (RLH); gap between Bluff Mountain and White Top, Fowler and Hoffman, June 19, 1950 (RLH); Chestnut Mountain, west of Volney, Dr. and Mrs. S. T. Brooks, Aug. 13, 1941 (CM); Elk Garden Ridge, between Mount Rogers and White Top, Dr. L. R. Cleveland, July 15, 1947 (RLH); also by Dr. and Mrs. Brooks, July 29, 1941 (CM). Washington County: Straight Mountain, east of Damascus, Brooks, July 23, 1941 (CM); Coocoo Mountain, near Damascus, Brooks, Aug. 19, 1941 (CM); base of Laurel Mountain, 4 miles southwest of Konnarock, Leslie Hubricht, May 28, 1951 (RLH).

TENNESSEE. Johnson County: Northeast corner, "across line from Taylor's Valley, Va.," Brooks, Aug. 19, 1941 (CM).

*Dixioria pela fowleri*, new subspecies

FIGURE 1,e

TYPE SPECIMENS: Holotype, allotype, and paratype (USNM 2013), topoparatypes (RLH); from Big Walker Mountain, along the west side near the top on U. S. Highway 52, about 10 miles east of Bland, Bland County, Va.; collected by J. A. Fowler and R. L. Hoffman, June 24, 1950.

DIAGNOSIS: Prefemoral process of male gonopod with a strong, somewhat rounded, subterminal shoulder along the outer margin; telopodite distally expanded with both subterminal processes well developed as in *D. p. coronata*, process B somewhat larger than in that form.

ECOLOGY: The following notes were made at the type locality: ". . . the area at which we collected seemed to be a talus slope of large boulders, but the whole area overgrown with a rich mesic woods

consisting chiefly of oak, hickory, and mountain maple. A large number of dead chestnut trees. The herb stratum dominated by *Impatiens biflora* and the ferns *Polystichum acrostichoides* and *Osmunda cinnamomea*. The logs and rocks almost entirely blanketed with moss." Millipeds collected at this place included *Uroblaniulus immaculatus* and *Apheloria kleinpeteri*. East of Marion, Va., *fowleri* was found in a typical *Magnolia-Liriodendron* "cove forest."

**DISTRIBUTION:** West side of the Iron Mountains and crossing the Great Valley to the folded Appalachians at Big Walker Mountain west of Wytheville. Known from the following localities:

**VIRGINIA.** Bland County: Big Walker Mountain, 10 miles east of Bland Court House, Fowler and Hoffman, June 24, 1950 (USNM, RLH). Grayson County: Comer's Rock, 3,800-4,000 feet, Leslie Hubricht, June 17, 1950 (RLH). Smyth County: Five miles east of Marion, Hoffman, May 4, 1954, Hoffman and Keeton, Aug. 22, 1954 (RLH). Washington County: Laurel Creek at Damascus, Leslie Hubricht, May 28, 1951 (RLH).

The range of this subspecies is the most interesting to be found for *Dixioria*. It is perhaps as great as that of *pela*, and embraces almost as much altitudinal variation. More pertinent is the fact that Big Walker Mountain is the only known station for a *Dixioria* outside the southern section of the Blue Ridge physiographic province. The situation is quite like that which obtains in the case of the plethodontid salamander *Plethodon jordani metcalfi* Brimley, which is likewise restricted to the Blue Ridge Province except for a single locality (Burke's Garden, Tazewell County, Va.) less than a dozen miles from Walker Mountain. This distribution is strongly suggestive of former continuity in a northwest-southeast direction, which is even today marked by the rugged country forming the divide between the headwaters of the Holston River and tributaries of the Kanawha.

Judging from the distribution of the two races, as well as the evidence available in gonopod structure, it seems likely that *coronata* is to be regarded as a high altitude counterpart of *fowleri*. That the two are subspecifically related is shown both by the quality level of gonopod differences as well as by two male specimens from Comer's Rock, which, although cited under *fowleri*, appear to be intergrades that I am unable to place in either of the two races. The gonopods are like those of *coronata* in the tibiotarsal processes, but similar to *fowleri* in the shape of the prefemoral process. Comer's Rock is also an intermediate locality both horizontally and vertically, as shown by the map.

Five males from Damascus are indistinguishable in every respect from the type series. But intergradation is certainly to be expected in the Damascus area, where future collecting can be profitably carried on.

*Dixioria pela wrighti*, new subspecies

FIGURE 1,f

TYPE SPECIMENS: Holotype, allotype, and paratype (USNM 2014), collected along the east side of Grandfather Mountain about 5 miles northeast of Linville, Avery County, N. C. (U. S. Highway 221), on Aug. 3, 1949, R. L. Hoffman.

DIAGNOSIS: This is one of the most distinct members of the genus. Prefemoral process of gonopod elongate, slender, and distally bent at a right angle; femur very slender, bent at two places rather than evenly arcuate; process B of tibiotarsus very large, becoming broader distally and abruptly truncate, and widely separated from the recurved end of the solenomerite.

ECOLOGY: The specimens taken by me were collected from beneath slabs of bark and under logs residual to a roadside lumbering operation. The elevation was about 3,200 feet, and the locality had been well-drained mesic forest. A large number of immature specimens of the salamander *Plethodon yonahlossee* Dunn was found.

DISTRIBUTION: On and adjacent to the Blue Ridge proper in the vicinity of the Grandfather Mountain massif in Avery and Watauga Counties, N. C., and probably in adjacent counties as well. Geographically as well as morphologically, *wrighti* is intermediate between *pela* and *coronata*. Collections made in the area north of Grandfather Mountain, particularly in Ashe County, N. C., and Johnson County, Tenn., are needed to close the present gap between the known ranges of the two. Known from the following localities:

NORTH CAROLINA. Avery County: On U. S. Highway 221, about 1 mile north of its intersection with the Blue Ridge Parkway, Hoffman, Aug. 3, 1949 (RLH); west side of Grandfather Mountain, between Banner Elk and Newland, Hoffman, May 30, 1953 (RLH); "Blowing Rock to Linville," 3,000 to 4,000 feet, collector not stated, Sept. 7, 1930 (MCZ). Watauga County: Howard's Creek, at Boone, Mike Wright, Aug. 25, 1948 (RLH).

The specimen from Boone appears to be an intergrade, being like *wrighti* in the shape of the prefemoral process and like *coronata* as regards the tibiotarsal processes. Much collecting still needs be done in the western part of Avery County, where *pela* and *wrighti* appear to intergrade.

*Dixioria dactylifera*, new species

FIGURE 2

TYPE SPECIMENS: Male holotype and topoparatypes of both sexes (AMNH), collected at Mill Hill, Ashe County, N. C., by C. M. and R. D. Breder in August 1910. Male paratype (USNM).

DIAGNOSIS: Similar in general to *Dixioria pela* as described in detail above, but differing from that species in the following respects: vertical groove of head distinct but not obviously punctate; caudal margin of collum swept forward laterally and its ends somewhat more acute, marginal groove of anterior-lateral edge more distinct; upper surface of paranota with a more pronounced vermiculate sculpture which extends slightly farther onto the dorsum than the very faint rugae of *pela*; all sternites with at least eight setae, some of those near the gonopods with as many as 16-20; coxal spines greatly reduced, apparent only as low remnants on a few of the caudalmost legs; sternal aperture of gonopods much larger and wider than in *pela*,

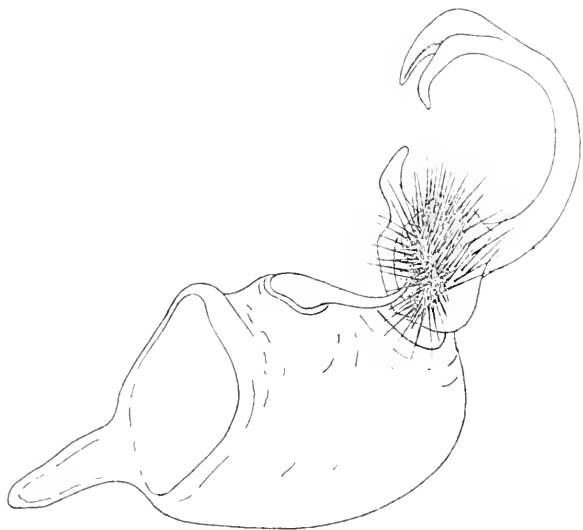


FIGURE 2.—Left male gonopod of male paratype of *Dixioria dactylifera*.

extending laterad at least 0.5 mm. beyond outer ends of coxal sockets of 8th legpair; process A of male gonopod absent, process B much enlarged, digitiform, larger than the solenomerite; and prefemoral process much shorter and bulkier.

ECOLOGY: I know nothing of the circumstances under which the type series was collected. The localities at which the Breders collected during the summer of 1910 are in the hilly country of central and western Ashe County, mostly at an elevation of less than 4,500 feet.

DISTRIBUTION: Known only from the type locality and immediate vicinity, in the central western part of Ashe County, N. C.

## RELATIONSHIPS

GENERIC: *Dixioria* is a member of the group of genera in which the sternites are not strongly spined or lobed, the repugnatorial pores open dorsolaterally through a distinct peritreme, the coxae of the gonopods are without a long process, the prefemora are globosely swollen and densely setose, and the telopodite is long, slender, and unbranched, forming nearly a complete circle. This group also includes the genera *Apheloria* and *Brachoria*, of which the former is obviously the closer relative. Both of these genera contain forms which are distinctly broader in proportion to their length than are the forms of *Dixioria*. *Brachoria* contains several species in which

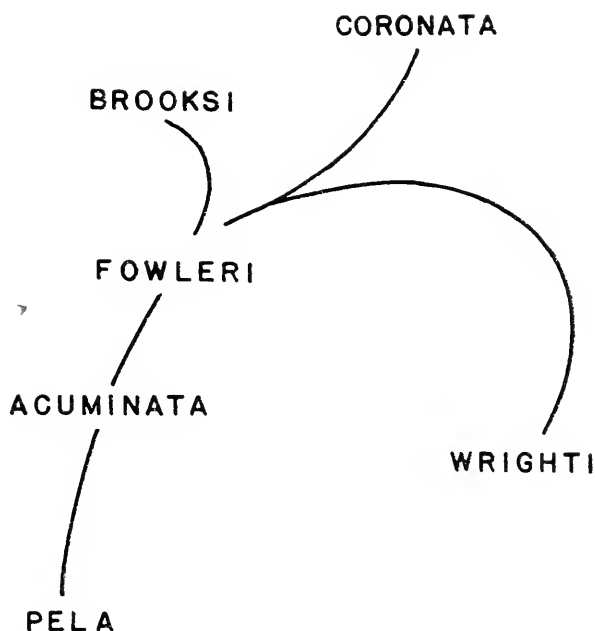


Figure 3.—Diagram of the probable relationships of the subspecies of *Dixioria pela*.

the paranota are broadly rounded caudally as in *Dixioria*, and the cyphopods of the two genera are similar. The males of *Brachoria*, however, are singular in that the telopodite is interrupted at about its midlength by a distinct constriction or flexible articulation. The gonopod of *Apheloria* differs chiefly in lacking subterminal processes on the telopodite, here again the cyphopods are quite similar. In none of the *Aphelorias*, however, are the caudal corners of the mid-body paranota rounded off.

SUBGENERIC: As here conceived, *Dixioria* is composed of two species, one of which is divisible into six geographic races. Both of

these species seem to have had a common ancestor; in fact, it is entirely probable that *dactylifera* is little more than an extreme development of the trend in the *pela*-group toward increase in the size of process B and reduction in the length and arch of the telopodite blade. It has also largely lost the small but acute coxal spines found in *pela*.

The subspecies of *pela* constitute a distinct *Rassenkreis* pattern,

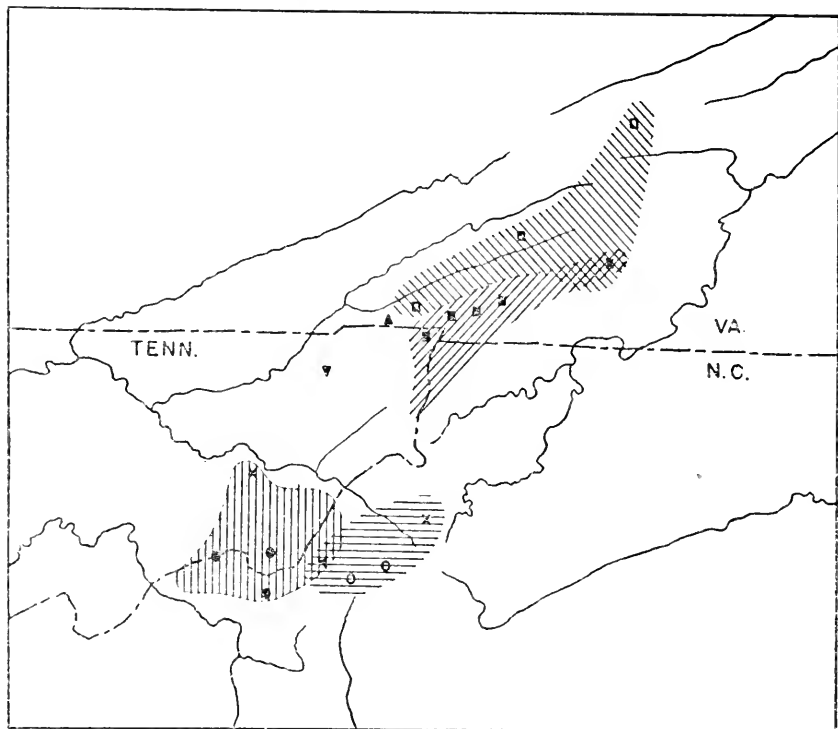


FIGURE 4.—Distribution of the subspecies of *Dixioria pela* in western North Carolina, northeastern Tennessee, and southwestern Virginia. The area is included by the headwaters of the Holston River on the upper left, of the New River on the lower right, and the Nolichucky River on the lower left. *Dixioria pela pela* is represented by solid circles, *D. p. acuminata* by a solid inverted triangle, *D. p. brooksi* by a solid upright triangle, *D. p. foxcleri* by open squares, *D. p. coronata* by solid squares, and *D. p. wrighti* by open circles. Intermediate samples are indicated by an X, and are discussed in the text under one form or the other of the two involved.

forming nearly a closed circle, and involving modification from a simple gonopod to a more complicated one (or vice versa) in three major succeeding forms. That systematically different forms rather than a single geographically variable one are involved is borne out by the fact that each of the groups is homogeneous within itself, even though its range may extend almost a hundred miles. Intergradation



between these large, relatively stable, populations, in the few known instances, occurs in narrow belts between them.

A diagram (fig. 3) indicates the relationships of the subspecies of *pela*, of which lines of affinity are obvious from both geographical and structural considerations. I have omitted only an indication of the *direction* of evolution. That it has been linear is indicated by the progressive nature of the changes and by the fact that the most modified form (*wrighti*) finds itself juxtaposed geographically with the simplest (*pela*). I believe that this militates effectively against the possibility of simultaneous, in situ evolution from a widespread parent stock.

The geographical evidence suggests a northward spread through the Iron Mountains, the encounter of a physiographic barrier (the reduction of the uplands by the New River and Tennessee River headwaters) and subsequent exploration back to the south on a subparallel but isolated mountain range. The presence of *Dixioria pela fowleri* on Big Walker Mountain in Bland County, Va., indicates that its isolation from the bulk of the *Dixioria* population to the southeast must have been relatively recent, perhaps by acceleration of base-leveling by a local uplifting during the Quarternary.

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**A REVISION OF THE FLIES OF THE GENUS RIVELLIA  
(OTITIDAE, DIPTERA) OF AMERICA NORTH OF MÉXICO <sup>1</sup>**

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**By Ryoji Namba <sup>2</sup>**

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The genus *Rivellia* was established in 1830 by Robineau Desvoidy to include three species, *R. herbarum*, *R. viridulans*, and *R. boscii*. Since then, as far as I know, papers by Loew (1873), Hendel (1914a), and Cresson (1924) are the only ones of an extensive nature on the *Rivellia* of America north of México.

The few papers mentioned above include no consideration of male genitalia, which have proved to be exceedingly useful systematically in other Diptera. Furthermore, these papers appear to be based on a very limited amount of material. The group, therefore, seemed to be in need of revision.

Study of the male genitalia, wing banding, chaetotaxy, pruinosity, color, and other characters has enabled me to recognize 30 species from the above-mentioned geographical area. Of these, 13 are described as new. Since the previously described species have been inadequately described in regard to the characters which were found to be most useful, they are redescribed more fully here.

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In the course of this study, the types of nine species (*Rivellia melliginis*, *R. brevifasciata*, *R. cognata*, *R. micans*, *R. floridana*, *R. variabilis*, *R. pallida*, *R. flavimana*, and *R. severini*) and a total of approximately 3,500 specimens were examined. I am unable to recognize *R. atriventris* Hendel.<sup>3</sup>

Very little is known of the biology of this genus. Fitch (1885) recorded his observations of the activities of the adults of *R. melliginis* on apple trees. Piersol's (1907) paper is the only other published biological note that has appeared. Herein are recorded biological notes on six species: *Rivellia flavimana*, *R. metallica*, *R. melliginis*, *R. coquilletti*, *R. pallida*, and *R. winifredae*. These notes will be found in the discussions of the respective species.

The readily discernible differences between the male aedeagi of most of the species offer good characters for the identification of species in this group. In most specimens the aedeagus is retracted and thus concealed within the abdomen. To expose the aedeagus, which is located terminally on the long phallosheca, it is first necessary to relax a dried specimen for a day. The phallosheca is usually looped beneath the fifth tergite on the right side of the abdomen. By using a No. 00 insect pin, which is hooked at the tip, the phallosheca can be pulled out from beneath the tergite. Further pulling of the phallosheca will expose the aedeagus. Sometimes the phallosheca will break before the aedeagus is exposed, in which case the tip of the abdomen is cut off at about the middle of the fourth segment with a pair of fine scissors. The severed part is then boiled or soaked in 10 percent KOH to get rid of noncuticular material which obscures the aedeagus. In fresh material the aedeagus should be exerted before flexibility is lost.

I am deeply indebted to Dr. C. E. Mickel and Dr. E. F. Cook of the Department of Entomology and Economic Zoology at the University of Minnesota for advice throughout this work. For the generous loan of material I wish to thank Dr. E. A. Chapin, who was curator of insects at the U. S. National Museum at the time this study was made, Mr. C. F. W. Muesebeck of the Section of Insect Identification and Parasite Introduction, Entomology Research Branch, U. S. Department of Agriculture, Mr. J. A. G. Rehn of the Academy of Natural Sciences of Philadelphia, Dr. C. H. Curran of the American Museum of Natural History, Mr. G. E. Shewell of the Canadian National Collection, Prof. H. J. Reinhard of the Agricultural and Mechanical College of Texas, Dr. J. L. Laffoon of Iowa State College, Dr. D. L. Wray of the North Carolina Department of Agriculture, Dr. H. Dietrich of Cornell University, Dr. G. F. Knowlton

<sup>3</sup> The combination of "rotgelbe" thorax, "Derobere Hinterkopf ist seitlich etwas blau," "Der Hinterleib ist ganz und gar metallisch blauschwarz, glänzend," and "die Kestalzelle hyalin" is not present in any of the species available.

of the Utah State Agricultural College, Dr. M. T. James of the State College of Washington, Prof. E. L. Kessel of the California Academy of Sciences, Dr. H. H. Ross of the State Natural History Survey Division of the State of Illinois, Dr. P. W. Fattig of Emory University, and Dr. R. H. Beamer of the University of Kansas. Thanks are also due to Mr. C. W. Sabrosky and Mr. R. R. Dreisbach for loan of material from their private collections, to Miss Mary Ellen Wartens and Mr. B. Ebel, graduate students at the University of Minnesota, for aid in collecting *Rivellia* specimens, and to Mr. G. Steyskal for his valuable suggestions and loan of material from his collection.

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Thanks are also due to Dr. John W. Moore, Botany Department, University of Minnesota, for his identification of plants. Lastly, to my wife, Winifred, I am grateful for her compilation of date and locality data and typing of the manuscript.

The following abbreviations are used in the distribution data: Snow Entomological Collection, University of Kansas, SEC; Division of Entomology, North Carolina Department of Agriculture, NC; Iowa State College, ISC; Cornell University, CU; U. S. National Museum, USNM; Illinois Natural History Survey, INHS; California Academy of Sciences, CAS; Emory University, EU; Academy of Natural Sciences of Philadelphia, ANSP; Agricultural and Mechanical College of Texas, TAM; Canadian National Collection, CAN; R. R. Dreisbach Collection, RRD; C. W. Sabrosky Collection, CWS; G. Steyskal Collection, GS; University of Minnesota, UM; American Museum of Natural History, AMNH; State College of Washington, SCW; GSMNP, Great Smoky Mountains National Park.

### Genus *Rivellia* Robineau Desvoidy

*Rivellia* Robineau Desvoidy, 1830, p. 729.—Rondani, 1856, p. 111; 1869, p. 28.—Schiner, 1864, p. 80.—Loew, 1873, p. 87.—Van Der Wulp, 1896, p. 179.—Williston, 1896, p. 116; 1908, p. 275.—Aldrich, 1905, p. 588.—Becker, 1905, p. 104.—Wingate, 1906, p. 326.—Hendel, 1914a, p. 152; 1914b, p. 85.—Curran, 1934, p. 281.—Hennig, 1945, p. 6.

TYPE SPECIES: *Musca syngenesiae* Fabricius (= *Rivellia herbarum* Robineau Desvoidy). Type designation by Rondani (1856).

The characters possessed by all *Rivellia* species considered in this paper are as follows:

HEAD: Frons dull, covered with short black setae; a narrow pruinose strip on each side on orbits. Upper fronto-orbital plates and ocellar triangle shining; upper fronto-orbital plates with two short reclinate setae on each side, the uppermost pair shorter, sometimes very much so; ocellar setae small, divergent, proclinate. Vertical setae long; inner verticals convergent, outer verticals divergent. Face concave from lateral view; with dorsal portion pruinose, ventral portion shining. Antenna with third segment elongated, almost reaching or surpassing oral margin; arista very short-plumose. Palpi with scattered black setae. Check with a strong seta on each side ventral to eye. Postcranium convex from lateral view, somewhat flattened dorsal to neck; with scattered black setae.

THORAX: Mesonotum with many black setae; pruinose except for border next to head which is shining; two notopleural, one supra-alar, one postalar, and one intra-alar setae always present on each side. Scutellum pruinose except for shining apex; with a pair of long black apical setae, a shorter pair of black lateral setae, and a few short, black, submarginal setae. Postscutellum pruinose laterally, shining along the midline. Propleuron with cluster of pale, weak setae on disc, pruinose next to front coxa. Mesopleuron pruinose next to coxa and ventral to anterior spiracle; a long black seta on dorsal posterior corner. Pteropleuron with a narrow pruinose strip on posterior margin. Prosternum lightly pruinose; with weak, pale setae.

THORACIC APPENDAGES: Front legs: Coxa with comblike row of black setae at tip on inside; femur with long setae on outside; tibia with comblike row of setae at tip. Middle legs: Tibia with one long spur at tip. Hind legs: Coxa with two long setae on outside; tibia with comblike row of setae at tip.

Wing banding may be reduced as in *R. brevifasciata*, but banding in general is as follows: First band extends along costal margin from base of wing to just proximad of tip of auxiliary vein, where it turns posteriorly toward and usually into discal cell proximad of anterior crossvein. Second band originates on costal margin just proximad of tip of first vein and extends posteriorly over anterior crossvein and usually into discal cell. Third band originates on costal margin proximad of tip of second vein and extends over posterior crossvein. Fourth band extends along costal margin from tip of second vein to tip of fourth vein. Discal cell elongate, broadened apically. Anterior crossvein meets the fourth vein distad of center of discal cell. First vein with many short, black setae on its entire length dorsally. Third vein sparsely covered with short, black setae dorsally. Costa covered with short, black setae.

ABDOMEN: First five tergites with short, reclinate, black setae. Ninth tergite and cerci of males covered with setae.

Pruinosity on the various parts of body white.

Key to the species of *Rivellia* of America north of México

1. Strong humeral setae present . . . . . 2  
 Strong humeral setae absent. . . . . 25
- 2 (1). Posterior dorsocentral setae absent. . . . . *R. variabilis* Loew  
 Posterior dorsocentral setae present . . . . . 3
- 3 (2). The part of first basal cell contiguous to second basal cell completely  
 banded; tip of first band joined to second band or very nearly so . . 4  
 That part of first basal cell not completely banded; either not banded  
 at all or partly banded; tip of first band distinctly separated from  
 second band . . . . . 9
- 4 (3). Front and middle femora yellowish . . . . . 5  
 Front and middle femora dark brown or black . . . . . 7
- 5 (4). Second basal cell completely banded or nearly so; second and third bands  
 converging, joined in the discal cell . . . . . *R. floridana* Johnson  
 Second basal cell hyaline; second and third bands subparallel . . . . 6
- 6 (5). Third band broader than hyaline strip between second and third bands;  
 no hyaline spot at junction of second and third veins.  
*R. coquilletti* Hendel  
 Third band narrower than hyaline strip between second and third bands;  
 a hyaline spot surrounding junction of second and third veins.  
 Males, *R. tersa*, new species
- 7 (4). Fourth band joined broadly to third band at costal margin, width of  
 fourth band at that point is from costa to third vein; first, second, and  
 third bands distinctly and broadly joined together at their tips.  
*R. conjuncta* Loew  
 Third and fourth bands joined at costal margin only between costa and  
 second vein; first, second, and third bands not joined together at  
 their tips, although first may be joined to second . . . . . 8
- 8 (7). A pair of additional strong setae present anterolateral to posterior  
 dorsocentrals; hyaline spot at junction of second and third veins large,  
 covering junction and extending distad.  
 Females, *R. tersa*, new species  
 No such setae present; hyaline spot small, not covering junction, con-  
 fined to anterior and proximad of junction. . *R. australis*, new species
- 9 (3). Costal cell hyaline, at most very faintly banded (see alternate) but not  
 darker than rest of the bands; body dark brown to black, not yel-  
 lowish . . . . . 10  
 Costal cell definitely banded, if faintly so, then body yellowish . . . 13
- 10 (9). Wing bands obsolete, consisting of faint spots . . . . . 11  
 Wing bands distinct . . . . . 12
- 11 (10). Anterior and posterior wing margins subparallel; anal angle prominent.  
*R. brevifasciata* Johnson  
 Wings narrowed toward base; anal angle nearly obsolete.  
*R. maculosa*, new species
- 12 (10). Second band with section in discal cell dislocated distally; prominent  
 seta present ventral to subalar; prosternum yellowish.  
*R. occulta* Van Der Wulp  
 Second band continuous; no prominent seta present ventral to subalar;  
 prosternum blackish . . . . . *R. metallica* Van Der Wulp

- 13 (9). Thorax yellowish in color . . . . . 14  
 Thorax not yellowish in color . . . . . 16
- 14 (13). First and second bands faintly joined at costal margin.  
**R. munda**, new species  
 First and second bands widely separated at costal margin . . . . . 15
- 15 (14). Apical part of aedeagus little shorter than basal part; apical part with definite neck, not appressed to basal part. **R. imitabilis**, new species  
 Apical part of aedeagus longer than basal part; apical part with no apparent neck, appressed to basal part . . . . . **R. pallida** Loew
- 16 (13). The part of first basal cell contiguous to second basal cell with hyaline area sharply wedgelike toward base of second basal cell.  
**R. winifredae**, new species  
 That part of first basal cell with hyaline area not sharply wedgelike, either rounded toward base or completely hyaline . . . . . 17
- 17 (16). All femora yellowish . . . . . 18  
 At least middle and hind femora blackish . . . . . 22
- 18 (17). Second and third bands definitely converging toward their tips; fourth band not conspicuously broadened at tip of third vein; the part of first basal cell contiguous to second basal cell completely hyaline or at most very faintly banded at base . . . . . **R. cognata** Cresson  
 Not with above combination of characters . . . . . 19
- 19 (18). Pruinosity on posterior dorsal corner of mesopleuron in the form of a rectangle; the part of first basal cell contiguous to second basal cell at most faintly banded basally . . . . . 20  
 Pruinosity on posterior dorsal corner of mesopleuron in the form of a right triangle; the part of first basal cell contiguous to second basal cell usually darkly banded basally . . . . . 21
- 20 (19). Apical part of aedeagus with lateral finlike structure on each side; fourth band usually widely separated from third band at costal margin . . . . . **R. texana**, new species  
 Apical part of aedeagus with no lateral finlike structure; fourth band usually narrowly joined to third band at costal margin. **R. vaga**, new species
- 21 (19). Width of fourth band at tip of third vein equal to or longer than length of posterior crossvein . . . . . **R. severini** Blanton  
 Width of fourth band shorter than length of posterior crossvein.  
**R. micans** Loew
- 22 (17). Front legs with coxae, tibiae, and femora of uniform yellowish color; the part of first basal cell contiguous to second basal cell hyaline, at most faintly banded basally . . . . . 23  
 Front legs with coxae, tibiae, and femora blackish; the part of first basal cell contiguous to second basal cell darkly banded basally . . . . . 24
- 23 (22). Third antennal segment obtusely rounded at tip; width of fourth band at tip of third vein as long as length of posterior crossvein.  
**R. michiganensis**, new species  
 Third antennal segment pointed at the anterior end of tip; width of fourth band at tip of third vein shorter than length of posterior crossvein . . . . . **R. flavimana** Loew
- 24 (22). Cerci of males extend beyond the proctiger by at least the length of the proctiger . . . . . **R. melliginis** (Fitch)  
 Cerci of males do not extend beyond the proctiger or do so only slightly.  
**R. viridulans** Robineau Desvoidy
- 25 (1). Thorax yellowish. . . . . 26  
 Thorax dark brown or blackish . . . . . 27



- 26 (25). Second band as broad as or narrower than hyaline strip between first and second bands; second basal and anal cells not banded.

**R. inacquata**, new species

Second band much broader than hyaline strip between first and second bands; second basal and anal cells banded. **R. succinata** (Wiedemann)

- 27 (25). Femora of front legs blackish . . . . . **R. socialis**, new species

Femora of front legs uniformly yellowish . . . . . 28

- 28 (27). Posterior dorsocentral setae absent; abdominal tergites distinctly pruinose; head directed anteriorly . . **R. boscii** Robineau Desvoidy

Posterior dorsocentral setae present; abdominal tergites not pruinose; head directed ventrally . . . . . 29

- 29 (28). Thorax and abdomen usually unicolorous, dark brown or black.

**R. steyskali**, new species

Thorax dark brown, black, or blackish green; abdomen yellowish . . 30

- 30 (29). Males with setae on fourth abdominal sternite directed posteriorly; aedeagus with apical part consisting of a long cylindrical neck, a small spherical head, and two long terminal tubes . . **R. colei**, new species

Males with setae on fourth abdominal sternite radially directed; aedeagus with apical part consisting of a bulbous base and two relatively short, slender, terminal tubes . . . . . **R. quadrifasciata** (Macquart)

### *Rivellia floridana* Johnson

FIGURE 2,*d*

*Rivellia floridana* Johnson, 1900b, p. 247.—Hendel, 1914a, p. 175.

TYPE LOCALITY: Dayton Island, Lake George, Fla. (ANSP).

FEMALES: Body length about 5.0 mm.

Head: Frons brownish yellow or yellow; ocellar triangle blackened, upper fronto-orbital plates concolorous with frons. Face with dorsal half pruinose, ventral half shining, smooth, yellow; parafacials and part of orbits ventral to each eye yellow. Antenna with first and second segments yellow; third segment with outside and anterior two-thirds of inside, or outside, only faintly blackened, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with ventral portion of face. Palpi yellow. Posteranium yellow, lightly pruinose.

Thorax: Mesonotum yellow; strong humeral and posterior dorso-central setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura yellow, mostly shining, pruinosity obscure except on laterotergite. Mesopleuron with posterior half rather densely covered with black setae; sternopleuron with black setae on disc; pteropleuron with black setae ventral to subalar. Laterotergite completely pruinose. Prosternum yellow.

Thoracic appendages: All legs yellow except for front and hind tarsi, which are very slightly blackened from third segment.

Wing (fig. 2,*d*) lengths of the two specimens examined are 3.7 and 4.1 mm. Bands brownish yellow, broad. First band broad at base, covers second basal cell and extends beyond discal cell where it faintly

joins second band. Second band separated from first band at costal margin, joined distinctly to third band in discal cell. Third and fourth bands narrowly joined at costal margin. Small whitish spot present on fourth vein just proximad of apex of second basal cell. Section of fourth vein proximad of anterior crossvein with deep bend. Halteres yellow toward base, remainder brownish.

Abdomen: Tergites shining, smooth; first two tergites and part of third yellow, remaining segments dark brown. Disc of first tergite with pale setae. Ovipositor sheath brownish yellow or brown.

SPECIMENS EXAMINED: FLORIDA: 2♀♀, Drayton Island, May 7-9.

REMARKS: The wing banding of this species distinguishes it from the other *Rivellia*.

*Rivellia coquilletti* Hendel

FIGURE 1, g-j

*Rivellia basilaris* Coquillett, 1900, p. 21 (not *Trypeta basilaris* Wiedemann, 1830).—Cresson, 1924, p. 225.

*Rivellia coquilletti* Hendel, 1914a, p. 180, pl. 1, fig. 26; 1914b, pl. 2, fig. 26.

LECTOTYPE: I hereby select as lectotype a male specimen bearing the labels "Type No. 4469, USNM," "Col.," "*Rivellia coquilletti* Hend.," and "*Rivellia basilaris* Coq."

TYPE LOCALITY: Southern Colorado.

MALES: Body length 3.7-5.0 mm.

Head: Frons yellowish brown; upper fronto-orbital plates and ocellar triangle black. Face with dorsal two-thirds pruinose, ventral one-third shining, of milky light gray color; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments brownish yellow; third segment with tip and outside blackened, remainder yellow, the tip pointed anteriorly. Anteclypeus dark brown or black. Palpi yellow. Posteranium dark brown or blackish green, pruinose.

Thorax: Mesonotum dark brown or blackish green; strong humeral and posterior dorsocentral setae present. Scutellum and post-scutellum concolorous with mesonotum. Pleura dark brown or blackish green, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of a marginal strip which extends from midpoint between anterior spiracle and dorsal posterior corner to dorsal posterior corner, then ventral to a point slightly past midpoint between dorsal posterior and ventral posterior corners. Sternopleuron with ventral corner and a very narrow strip on posterior margin pruinose; disc with scattered pale setae. Disc of pteropleuron with scattered pale setae, black setae present or absent ventral to subalar. Hypopleuron with

shining disc, borders narrowly pruinose. Laterotergite completely and densely pruinose. Prosternum black.

Thoracic appendages: Front legs: Coxae and femora yellow; tibiae wholly yellow, yellow at base and gradually blackened toward tip, wholly dark brown, or wholly black; tarsi unicolorous, varying from yellow to dark brown, never darker than tibiae. Middle legs: Coxae dark brown; femora yellow; tibiae yellow at extreme base, remainder dark brown or black; tarsi wholly yellow. Hind legs: Coxae with brown spot at base on outside, remainder yellow; femora yellowish brown at tip, remainder yellow; tibiae dark brown or black; tarsi blackened from third segment, remaining segments yellow.

Wing (fig. 1,g) length 2.9–3.7 mm. Bands black, very broad. First and second bands widely separated at costal margin, joined broadly posterior to third vein; third and fourth bands broadly joined at costal margin. Second and third bands appear perpendicular to costal margin. First basal cell completely banded. Section of fourth vein proximad of anterior crossvein almost straight. I have seen one specimen with second and third bands joined in the discal cell. Halteres brownish yellow or brown.

Abdomen: Tergites shining, rugose. The color pattern varies somewhat. Usually with a dark brown transverse band at base next to thorax, remainder of first, and the second and third tergites yellowish except for a dark brown median longitudinal band on third tergite. Remaining tergites dark brown or blackish green. Basal transverse band sometimes absent, median longitudinal band on third tergite sometimes absent, both sometimes absent. Disc of first tergite with pale setae. Genitalia (fig. 1,i,j) with apical part of aedeagus conical in shape, the two filamentous terminal tubes little shorter than base of apical part.

FEMALES: Body length 3.8–5.0 mm.; wing length 3.1–4.0 mm. Ovipositor sheath black. Otherwise similar to males.

SPECIMENS EXAMINED: IOWA (10♀♀, 13♂♂): Amana, Clinton, Counties 3, 34, Pleasant Valley; June 22–Aug. 12. MANITOBA (1♀): Winnipeg; Aug. 21. MINNESOTA (86♀♀, 54♂♂): Big Stone County, Madison, Olmsted County, Mine dump on north bank of Snake River 4 miles east of Pine City, Mouth of Snake River (Pine County), St. Anthony Park (Ramsey County), Rock County, Sherburn; May 19–Aug. 16. MONTANA (1♀, 3♂♂): No data. NEBRASKA (1♀, 1♂): Valentine; June 11. NORTH DAKOTA (2♂♂): White, Winner; July 4–12.

REMARKS: The banding of the wings distinguishes this species from other *Rivellia*. Numerous specimens of this species were caught along a riverbank on *Carex aquatilis* Wahlenb.

*Rivellia conjuncta* Loew

FIGURE 6,g-j

*Rivellia conjuncta* Loew, 1873, p. 88, pl. 8, fig. 3 (not *Rivellia conjuncta* Loew of Van Der Wulp, 1898).—Hendel, 1914a, p. 176.

The species thought to be *R. conjuncta* by Van Der Wulp in 1898 was recognized by Hendel (1914a) and by Cresson (1924) to be another species. Hendel names the species *R. wulpiana*, and Cresson, who apparently had no knowledge of Hendel's paper, named the same species *R. vanderwulpi*. *R. vanderwulpi* Cresson, is, therefore, a junior synonym of *R. wulpiana* Hendel.

TYPE: The type of this species has been destroyed. It was collected in Maryland and was formerly deposited in the Museum of Comparative Zoology.

MALES: Body length 3.5–5.0 mm.

Head: Frons yellowish brown or reddish brown; upper fronto-orbital plates and ocellar triangle blackened; pruinose strip on frontal orbits perceptibly broader than those of other *Rivellia*. Face with little more than dorsal half pruinose, remainder shining, smooth, dark brown or black medioventrally with brownish yellow lateral strip on each side terminating just before the oral margin; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments yellow; third segment with tip, outside, and anterior side of inside blackened, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with medioventral portion of face. Palpi yellow. Posteranium black, pruinose.

Thorax: Mesonotum dark brown or black; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura dark brown or black, mostly shining. Mesopleuron with scattered black setae on posterior half; pruinosity at dorsal posterior corner absent. Sternopleuron with narrow pruinose strip on ventral margin; disc with scattered black setae. Hypopleuron with shining disc, borders narrowly pruinose. Laterotergite completely and densely pruinose. Prosternum black.

Thoracic appendages: All legs with coxae, femora, and tibiae dark brown or black; front tarsi blackened from third segment, remaining segments yellow; middle and hind tarsi blackened from fourth segment, remaining segments yellow.

Wing (fig. 6,g) length 3.1–3.7 mm. Bands dark brown, very broad. First and second bands widely separated at costal margin, joined broadly posterior to third vein; third and fourth bands broadly joined at costal margin. First basal cell almost completely banded; the apex of the hyaline triangle between first and second bands ends anywhere between third and fourth veins. Second basal cell completely banded. Discal cell completely banded at base. First and

second bands joined broadly to third band posterior to fifth vein. Section of fourth vein proximad of anterior crossvein with definite bend. Halteres with dark brown capitulum, pedicel brownish yellow.

Abdomen: Tergites shining, rugose, black. Disc of first tergite with no pale setae evident. Genitalia (fig. 6,*i,j*) with apical part of aedeagus consisting of a bulbous base and two filamentous terminal tubes which are subequal in length to bulbous base.

FEMALES: Body length 3.5–5.4 mm; wing length 3.0–4.0 mm. Ovipositor sheath black. Otherwise similar to males.

SPECIMENS EXAMINED: CONNECTICUT (1♀): Willington; no date. KANSAS (2♀♀, 1♂): Baldwin, Douglas County, Medora (Sand Dunes); May 26–July. MASSACHUSETTS (4♂♂): Atco, Brown Mills, Buena; June 11–25. NEW YORK (4♀♀, 5♂♂): Farmingdale (Long Island); June 5–14. NORTH CAROLINA (2♀♀, 1♂): Pinebluff, Raleigh, Toxaway; May 24–29. OKLAHOMA (1♀): Afton; May 16. VIRGINIA (2♀♀): Falls Church, Veitch; June 9. TEXAS (10♀♀, 1♂): College Station, Liberty, Walker County; March 25–April 21.

REMARKS: The salient character of this species is the wing banding. The absence of pruinosity on the posterior part of the mesopleuron and the rather broad pruinose strip on each side on frontal orbits are also peculiar to this species.

*Rivellia tersa*, new species

FIGURE 8, *a-c*

HOLOTYPE: Male. Body length about 4.6 mm.

Head: Frons yellowish brown; ocellar triangle black; upper fronto-orbital plates concolorous with frons. Face with dorsal half pruinose, ventral half shining, rugulose, yellow; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments brownish yellow; third segment with outside and anterior part of inside blackened, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with ventral portion of face. Palpi yellow. Posteranium yellowish brown, lightly pruinose.

Thorax: Mesonotum pale brownish yellow, with black and brown blotches which are probably due to contents of thorax; strong humeral and posterior dorsocentral setae present, in addition a pair of setae anterolateral to posterior dorsocentral setae present. Scutellum and postscutellum unicolorous, pale brownish yellow. Mesopleuron with pruinose area at dorsal posterior corner in form of right triangle, one side reaching half way to ventral posterior corner, the other side reaching half way to anterior spiracle. Sternopleuron with ventral corner and narrow strip on posterior margin pruinose; disc with scattered pale setae. Disc of pteropleuron with scattered pale setae,

few black setae present ventral to subalar. Hypopleuron with shining central spot, remainder pruinose. Laterotergite completely pruinose. Prosternum brownish yellow.

Thoracic appendages: Front and middle legs yellow, except for tarsi which are slightly blackened from fourth segment. Hind legs with coxae and femora yellow; tibiae yellowish brown; tarsi very slightly blackened from fourth segment, remaining segments yellow.

Wing (fig. 8,a) length 3.0 mm., width 1.5 mm. Bands brown. First and second bands separated at costal margin, joined in discal cell; third and fourth bands distinctly joined at costal margin. Second and third bands appear perpendicular to costal margin. The part of first basal cell contiguous to second basal cell completely banded. Section of fourth vein proximad of anterior crossvein with very slight bend. A hyaline spot present around junction of second and third veins. Halteres brownish yellow toward base, remainder brown.

Abdomen: Tergites shining, rugose, dark brown, somewhat lighter toward base of abdomen. Disc of first tergite with pale setae. Genitalia (fig. 8,c) with apical part of aedeagus consisting of an apically tapered base and two long filamentous terminal tubes about nine times the length of basal part of aedeagus.

ALLOTYPE: Female. Body length about 4.7 mm. Frons reddish brown; postcranium dark brown. Thorax dark brown; pruinose triangle on mesopleuron more extensive, one side reaches the ventral posterior corner and the other side reaches the anterior spiracle. Front legs: Coxae, femora, and tibiae yellowish brown; tarsi blackened slightly from second segment, remaining segments yellow. Middle legs: Coxae yellowish brown; femora yellowish toward tip, remainder brown; tibiae brown; tarsi slightly blackened from third segment, remaining segments yellow. Hind legs: Coxae and tibiae brown; femora yellowish at tip, remainder brown; tarsi slightly blackened from third segment, remaining segments yellow. Abdominal tergites black; ovipositor sheath black. Otherwise similar to holotype.

SPECIMENS: Holotype, ♂, Mountain Park, N. Mex., June 27, 1940, R. H. Beamer (SEC); allotype, ♀, Ruby, Ariz., July 27, 1941, E. L. Todd (SEC).

REMARKS: The important diagnostic characters of this species are the peculiar banding of the wings, the additional pair of strong setae anterolateral to the posterior dorsocentral setae, and the male genitalia.

*Rivellia australis*, new species

FIGURE 7,c-g

HOLOTYPE: Female. Body length about 3.5 mm.

Head: Frons reddish brown; upper fronto-orbital plates and ocellar triangle blackened. Face with dorsal half pruinose, ventral half

shining, rugulose, brown; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments blackened on outside, yellow inside; third segment brownish yellow only on the posterior one-third of inside, remainder blackened, the tip pointed anteriorly. Anteclypeus dark brown. Palpi yellow. Postcranium black, lightly pruinose.

Thorax: Mesonotum black; strong humeral and posterior dorso-central setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura dark brown, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of right triangle, one side reaching almost to ventral posterior corner, the other almost to anterior spiracle. Sternopleuron with a narrow pruinose strip on ventral margin and a much narrower strip on posterior margin; disc with few scattered pale setae. Disc of pteropleuron with scattered pale setae, one black seta present ventral to subalar. Hypopleuron with shining central spot, remainder pruinose. Laterotergite with shining spot on dorsal posterior corner, remainder densely pruinose. Prosternum dark brown.

Thoracic appendages: Legs with coxae, femora, and tibiae dark brown; front and hind tarsi blackened from third segment, remaining segments yellow; middle tarsi wholly yellow.

Wing (fig. 7,e) length 2.9 mm., width 1.2 mm. Bands dark brown. First and second bands separated at costal margin, very narrowly separated in discal cell; third and fourth bands very narrowly joined at costal margin. Second and third bands appear perpendicular to costal margin. The part of first basal cell contiguous to second basal cell completely banded. Section of fourth vein proximad of anterior crossvein with very slight bend. A very narrow hyaline slit present anterior and basad of junction of second and third veins. Halteres with pedicel brownish yellow, capitulum dark brown.

Abdomen: Tergites shining, rugose, black. Disc of first tergite with pale setae. Ovipositor sheath black.

ALLOTYPE: Male. Body length about 2.7 mm.; wing length 2.2 mm., width 1.0 mm.; first and second antennal segments not blackened on outside; genitalia (fig. 7,g) with apical part of aedeagus consisting of a small bulbous base and two long filamentous terminal tubes about four times the length of basal part of aedeagus. Otherwise similar to holotype.

PARATYPES: Three females. Body length 3.3–4.2 mm.; wing length 2.5–4.0 mm. In one specimen the front coxae yellowish brown on inside. In two specimens the first and second bands of wing definitely joined in discal cell and third and fourth bands broadly joined at costal margin. Otherwise essentially similar to holotype.

SPECIMENS: Holotype, ♀, Tumicacari Mts., Ariz., July 22, 1938,

R. H. Beamer (SEC). Allotype, ♂, same data as holotype. Paratypes: ARIZONA: Mud Springs Station, Catalinas (2♀♀, July 17–20, 1916, "share with Clark and A. N. S. P."), Sunnyside Canyon, Huachuca Mts. (1♀, July 9, 1940, D. E. Hardy). (In SEC, AMNH.)

REMARKS: This species appears to be related to *R. tersa*, from which it can be distinguished by its smaller size, the smaller hyaline spot at the junction of the second and third veins as stated in key, and the male genitalia. It also appears to be related to *R. longicornis* Van Der Wulp (1898, p. 384, pl. 10, fig. 15), from which it can be distinguished by its lack of hyalinity between second and third veins at their junction and the joining or very narrow separation of first and second bands in the discal cell.

*Rivellia brevifasciata* Johnson

FIGURE 9, *h-k*

*Rivellia brevifasciata* Johnson, 1900a, p. 326.—Hendel, 1914a, p. 177.—Cresson, 1924, p. 229.

TYPE LOCALITY: Atco, N. J. (ANSP).

MALES: Body length 3.0–5.2 mm.

Head: Frons yellowish brown; upper fronto-orbital plates and ocellar triangle blackened. Face with dorsal half pruinose, ventral half shining, smooth, dark brown or black; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments yellow; third segment with tip, outside, and sometimes anterior side of inside blackened, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with ventral portion of face. Palpi dark brown. Posteranium black, pruinose.

Thorax: Mesonotum dark brown or black with blue-green reflections; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura concolorous with mesonotum, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of right triangle, one side reaching two-thirds distance to ventral posterior corner and the other reaching two-thirds distance to anterior spiracle. Sternopleuron with ventral corner pruinose; disc with few scattered pale setae. Disc of pteropleuron with scattered pale setae, few black setae present ventral to subalar. Hypopleuron with shining central spot, remainder pruinose. Laterotergite completely and densely pruinose. Prosternum black.

Thoracic appendages: Front legs: Coxae yellow, sometimes with brown spot on outside at base; femora yellow; tibiae yellow or brownish yellow; tarsi wholly yellow or slightly blackened from second segment. Middle legs: Coxae dark brown on outside at base, re-



mainder yellow; femora and tibiae yellow; tarsi wholly yellow or slightly blackened from third segment. Hind legs: Coxae yellow to yellowish brown; femora yellow; tibiae yellow to yellowish brown; tarsi wholly yellow or slightly blackened from third segment.

Wing (fig. 9, *h*) length 2.2–3.3 mm. Bands brown; much reduced, somewhat similar to those of *R. vaga*. First band consists of spot at junction of second and third veins. Second band extends from proximad of tip of first vein to fourth vein over the anterior crossvein, faint between second and third veins. Third band extends from proximad of tip of second vein toward posterior crossvein but not surpassing fourth vein. Fourth band extends from about half way between tips of second and third veins to tip of fourth vein. Sometimes all bands obsolete. Section of fourth vein proximad of anterior crossvein straight or with very slight bend. The part of first basal cell contiguous to second basal cell completely hyaline. Anal angle prominent. Halteres yellow.

Abdomen: Tergites shining, rugose, dark brown or black with blue-green reflections. Disc of first tergite with pale setae. Genitalia (fig. 9, *j, k*) with apical part of the aedeagus flattened dorsoventrally, shaped like an elongated lyre from dorsal view.

FEMALES: Body length 3.5–4.5 mm.; wing length 2.6–3.3 mm. Ovipositor sheath concolorous with abdominal tergites. Otherwise similar to males.

SPECIMENS EXAMINED: GEORGIA (3♀♀, 1♂): Augusta, Tybee Island; June 4–July 26. ILLINOIS (1♀): Bishop; June 23. KANSAS (1♀, 2♂♂): Saline County, Medora (sand dunes); June 7–8. MARYLAND (2♀♀): Bladensburg; June 23. MICHIGAN (2♀♀): St. Joseph; June 23. MISSISSIPPI (1♂): Oxford; May. NORTH CAROLINA (8♀♀, 3♂♂): Raleigh; April 16–June 28. NEW YORK (6♀♀, 5♂♂): Farmingdale (Long Island); June 6.

REMARKS: This species can be distinguished from other *Rivellia* by the shape and banding of the wings and the male genitalia.

*Rivellia maculosa*, new species

FIGURE 5, *j–l*

HOLOTYPE: Male. Body length about 2.7 mm.

Head: Frons reddish brown; upper fronto-orbital plates and ocellar triangle blackened. Face with dorsal half pruinose, ventral half shining, smooth, brown; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments yellow; third segment blackened at tip and on outside, remainder yellow, the tip pointed anteriorly. Anteclypeus brown. Palpi brown. Postcranium black, pruinose.

Thorax: Mesonotum black; strong humeral and posterior dorso-central setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura dark brown, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of rectangle, one side extending two-thirds distance to ventral posterior corner, the other side extending about half way to anterior spiracle. Sternopleuron with ventral corner pruinose, a broken medial pruinose band extending from pruinose corner to dorsal margin of sternopleuron; disc with few scattered pale setae. Disc of pteropleuron with few scattered pale setae, no black seta evident ventral to subalar. Hypopleuron with small shining central spot, remainder pruinose. Laterotergite pruinose on anterior half, remainder shining. Prosternum black.

Thoracic appendages: Front and middle legs wholly yellow. Hind legs with coxae, femora, and tarsi yellow, tibiae faintly brownish toward base, yellow toward tip.

Wing (fig. 5,j) length 2.0 mm., width 0.8 mm. Bands brown, much reduced. First band consists of spot at junction of second and third veins. Second band extends from proximad of tip of first vein to fourth vein over the anterior crossvein, faint between second and third veins. Third band extends from proximad of tip of second vein toward posterior crossvein but not passing third vein. Fourth band consists of relatively large spot at tip of third vein. The part of first basal cell contiguous to second basal cell completely hyaline. Section of fourth vein proximad of anterior crossvein with very slight bend. Anal angle obsolete. Halteres with yellow pedicel and brown capitulum.

Abdomen: Tergites shining, slightly rugose, black. Disc of first tergite with pale setae. Genitalia (fig. 5,k) with apical part of aedeagus consisting of a base bearing a sharp-pointed dorsal horn and two filamentous terminal tubes, which are little shorter than basal part of aedeagus.

ALLOTYPE: Female. Body length about 3.1 mm.; wing length 2.2 mm., width 1.0 mm. Ovipositor sheath black. Otherwise similar to holotype.

PARATYPES: 19 females, 19 males. Body length, males 2.8–3.5 mm., females 2.5–3.7 mm.; wing length, males 1.8–2.5 mm., females 2.0–2.5 mm. Both sexes sometimes having pteropleuron with one or two black setae ventral to subalar; halteres and palpi variable in color, from brownish yellow to brown. One male specimen with scutellum, postscutellum, laterotergite, pteropleuron, and mesopleuron brownish yellow, remainder of thorax dark brown.

SPECIMENS: Holotype, ♂, Perry, Ga., Aug. 12, 1939, D. E. Hardy (SEC). Allotype, ♀, same data as holotype. Paratypes: ALABAMA: Garden City (3♀♀, July 7, 1939, R. H. Beamer; 2♀♀, July 7, 1939,

D. E. Hardy; 1 ♂, July 7, 1939, P. B. Lawson). CANADA: Watertown Lake Park, Alberta (1♀, 1♂, July 26, 1946, C. E. Mickel). FLORIDA: Lacoochee (1♂, Aug. 9, 1939, D. E. Hardy); Wakulla (1♂, July 10, 1939, D. E. Hardy). GEORGIA: Adel (1♀, Aug. 11, 1939, J. D. Beamer); Austell (1♂, Aug. 27, 1910); Billy's Island, Okefenokee Swamp (1♂, June, 1912); Griffin (2♀♀, 2♂♂, Aug. 12, 1939, R. H. Beamer; 1♀, 2♂♂, Aug. 12, 1939, E. G. Wegenek; 2♀♀, Aug. 12, 1939, A. T. Hardy; 1♂, Aug. 12, 1939, J. D. Beamer); Perry (5♀♀, 5♂♂, Aug. 12, 1939, D. E. Hardy); Tifton (1♀, Aug. 11, 1939, R. H. Beamer); Waycross (1♂, May 8, 1911). NORTH CAROLINA: Goldsboro (1♂, July 20, 1946, M. W. Wing); Raleigh (1♂, early July, Metcalf; 1♀, July 8, 1938, Wilson). (Deposited in SEC, UM, NC, USNM, and CU.)

REMARKS: The members of this species are among the smallest *Rivellia* of America north of México. *R. maculosa* can be distinguished from the other species by the reduced wing banding, obsolete anal angle of wing, and the male genitalia.

### *Rivellia occulta* Van Der Wulp

FIGURE 8, *d-g*

*Rivellia occulta* Van Der Wulp, 1898, p. 382, pl. 10, fig. 8.—Hendel, 1914a, p. 178, pl. 2, fig. 33; 1914b, pl. 2, fig. 33.—Cresson, 1924, p. 229.

TYPE LOCALITY: Chilpancingo (4,600 ft.) and Omilteme (8,000 ft.), both in Guerrero, México. Location of type unknown.

MALE: Body length about 2.7 mm.

Head: Frons yellow toward antenna, brown toward vertex; upper fronto-orbital plates and ocellar triangle blackened. Face with dorsal half pruinose, ventral half shining, rugulose, pale yellowish gray; parafacials and part of orbits ventral to each eye concolorous with face. Antenna with first and second segments yellow; third slightly blackened outside, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with ventral portion of face, rugulose. Palpi yellow. Posteranium dark brown, rather densely pruinose.

Thorax: Mesonotum dark brown; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura dark brown, mostly shining. Mesopleuron with scattered pale setae on posterior half; posterior half pruinose. Sternopleuron with broad medial pruinose band which extends from the ventral corner to the dorsal margin where it becomes continuous with pruinose band on mesopleuron; disc with scattered pale setae. Disc of pteropleuron with scattered pale setae and one prominent black seta ventral to subalar. Hypopleuron with shining central spot, remainder pruinose. Laterotergite completely and densely pruinose. Prosternum pale yellow.

Thoracic appendages: Front and middle legs completely yellow. Hind legs: Coxae and femora yellow; tibiae yellowish brown; tarsi very slightly blackened from fourth segment, remaining segments yellow.

Wing (fig. 8,*d*) length 2.3 mm., width 0.9 mm. Bands light brown. Base of wing completely hyaline. First and second bands subparallel, slightly oblique to costal margin, joined at costal margin; sections of both bands in discal cell dislocated distally. Third band appears perpendicular to costal margin. Fourth band consists of large spot at apex of third vein. Section of fourth vein proximad of anterior crossvein with very slight bend. The part of first basal cell contiguous to second basal cell very faintly banded. Second basal cell banded at apex. Halteres brownish yellow.

Abdomen: Tergites dull, smooth, black. Disc of first tergite with pale setae. Genitalia (fig. 8,*f,g*) with apical part of aedeagus consisting of a slender base with two long, filamentous, randomly twisted, terminal tubes and an apparently colorless, elongated, membranous, vesicalike structure attached to the base of apical part.

FEMALES: Body length 3.1–3.7 mm.; wing length 2.2–3.2 mm.; frons yellowish brown or reddish brown; ovipositor sheath dark brown. Otherwise similar to the male.

SPECIMENS EXAMINED: ARIZONA (3♀♀, 1♂): Huachuca Mts. (Sunnyside Canyon), Ruby; July 13. NEW MEXICO (1♀): Silver City; July 22.

REMARKS: This species is easily distinguished from other *Rivellia* by the banding of the wings, the presence of a prominent seta ventral to the subalar, a broad pruinose band on the pleuron which extends from the ventral corner of the sternopleuron to the dorsal margin of the mesopleuron, and the male genitalia.

The presence of the elongated, membranous vesica on the apical part of the aedeagus is unique in this species. The location of the gonopore is uncertain. In view of the randomly twisted terminal tubes, it is suggested that the gonopore is located on the vesica.

#### *Rivellia metallica* (Van Der Wulp)

FIGURE 4,*e-h*

*Herina metallica* Van Der Wulp, 1867, p. 154, pl. 5, fig. 10.

*Rivellia metallica* (Van Der Wulp) Hendel, 1914a, p. 178, pl. 2, fig. 34; 1914b, pl. 2, fig. 34.—Cresson, 1924, p. 229.

TYPE LOCALITY: Unknown.

MALES: Body length 2.7–4.2 mm.

Head: Frons reddish brown or dark brown; upper fronto-orbital plates and ocellar triangle, blackened. Face with dorsal half pruinose, ventral half shining, smooth, dark brown or black medioventrally.

with yellowish brown lateral strip on each side which terminates just before oral margin; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments brownish yellow; third segment with tip, outside, and anterior side of inside blackened, remainder yellow, sometimes almost wholly blackened, the tip pointed anteriorly. Anteclypeus concolorous with medioventral portion of face. Palpi brown. Posteranium black, pruinose.

Thorax: Mesonotum black or dark brown; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura dark brown or black, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of a right triangle, one side reaching two-thirds distance to ventral posterior corner and the other reaching two-thirds distance to anterior spiracle. Sternopleuron with narrow pruinose strip on ventral margin and a narrower strip on posterior margin; disc with scattered pale setae. Disc of pteropleuron with scattered pale setae, black setae present or absent ventral to subalar. Hypopleuron with disc shining, borders narrowly pruinose. Laterotergite completely and densely pruinose. Prosteronum black.

Thoracic appendages: Front legs: Coxae, femora, and tibiae yellow; tarsi with fifth segment slightly blackened, remaining segments yellow. Middle legs: Wholly yellow. Hind legs: Coxae yellow; femora wholly yellow or brown at tip on inside, sometimes on outside also; tibiae yellow at tip, remainder brownish yellow or brown; tarsi wholly yellow or fifth segment slightly blackened.

Wing (fig. 4,e) length 2.1–3.0 mm. Bands dark brown or black, narrow. First and second bands widely separated at costal margin; third and fourth bands definitely separated at costal margin. Costal cell and the part of first basal cell contiguous to second basal cell completely hyaline or at most very faintly banded basally. Section of fourth vein proximad of anterior crossvein with slight bend. Halteres with pedicel brownish yellow, capitulum dark brown.

Abdomen: Tergites shining, smooth, black or dark brown. Disc of first tergite with pale setae. Genitalia (fig. 4,g,h) with apical part of aedeagus somewhat conical in shape; the two filamentous terminal tubes little longer than base of apical part. The apical part appressed at base to basal part of aedeagus.

SPECIMENS EXAMINED: ILLINOIS (1 ♂): Savanna; June 12. MARYLAND (2 ♀♀, 2 ♂♂): Cabin John, Forest Glen.; May 16–July 29. MICHIGAN (1 ♀): Detroit; June 24. MINNESOTA (279 ♀♀, 174 ♂♂): St. Paul Water Works (Anoka County), Hennepin County, Mississippi Bluff one-half mile north of state line (Houston County), Lake

Vadnais, Oak Forest (Ramsey County), Snail Lake, St. Anthony Park, Sucker Lake, University Farm; May 23–July 18. MISSOURI (1♀): Parkville; May 25. NEW YORK (13♀♀, 5♂♂): Centereach (Long Island), Flatbush (Long Island), Gowanda, Ithaca, Pocantico Hills, Tuxedo (Station for Study of Insects); May 26–July 9. ONTARIO (1♀, 1♂): Simcoe, Toronto; May 5–July 1. PENNSYLVANIA (1♀): Delaware County; July 7. VIRGINIA (1♀, 4♂♂): Great Falls, Rosslyn; May 2–13.

REMARKS: This species can be distinguished from other *Rivellia* by the banding of the wings, smooth abdomen, male genitalia, and the general body color.

This species, as with *R. flavimana* and *R. pallida*, is found abundantly on hogpeanut, *Amphicarpa bracteata* (L.) Fernald. I had the opportunity to observe the increase and decrease of the population densities of these three species in a patch of *A. bracteata* about three yards square in 1951 and 1952. Although actual counts were not made, these changes in population were very evident. *R. flavimana* was first to appear in the spring. After its population reached a peak and began to dwindle *R. metallica* made its appearance. By the time the population of *R. metallica* reached its peak there were few or no *R. flavimana* found. *R. pallida* appeared when the *R. metallica* population began to decrease, and, as with the previous sequence, there were few or no *R. metallica* left when the *R. pallida* population was at its peak.

*Rivellia munda*, new species

FIGURE 7, a-d

HOLOTYPE: Male. Body length about 5.0 mm.

Head: Frons yellow; ocellar triangle slightly blackened; upper fronto-orbital plates concolorous with frons. Face with dorsal half pruinose, ventral half shining, pale yellow, smooth; parafacials and part of orbits ventral to each eye yellow. Antenna wholly yellow; tip of third segment pointed anteriorly. Anteclypeus yellow. Palpi yellow. Posteranium pale yellow, pruinose.

Thorax: Mesonotum yellow; strong humeral and posterior dorso-central setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura yellow, mostly shining; pruinosity obscure except on sternopleuron and laterotergite. Mesopleuron with scattered pale and black setae on posterior one-third; sternopleuron with narrow pruinose strip on ventral margin and much narrower strip on posterior margin, center of disc with cluster of black setae; pteropleuron with scattered pale setae, few black setae present ventral to subalar. Laterotergite completely pruinose. Prosternum yellow.

Thoracic appendages: Legs yellow except for tarsi of front and hind legs which are blackened from the third segment and tarsi of middle legs which are blackened from the fourth segment.

Wing (fig. 7,*a*) length 3.3 mm., width 1.5 mm. Bands yellowish brown. First and second bands faintly joined at costal margin; third and fourth bands narrowly joined at costal margin; second and third bands not joined in discal cell. The part of first basal cell contiguous to second basal cell banded at base, with semicircular hyaline spot anterior to apex of second basal cell. Section of fourth vein proximad of anterior crossvein with definite bend. Halteres yellow.

Abdomen: Tergites shining, smooth, yellowish brown. Disc of first tergite with pale setae. Genitalia (fig. 7,*c,d*) with apical part of aedeagus consisting of a flattened base and two long terminal tubes, one somewhat shorter than the other. The tips of the tubes are rather peculiar. Each is excavated at the tip with a central cone arising from the bottom of the pit. From the apex of each cone a tiny tube protrudes. The gonopores are apparently located at the apices of these tubes.

ALLOTYPE: Female. Body length about 5.0 mm.; wing length 4.0 mm., width 1.7 mm.; ovipositor sheath yellow on basal half, blackened on apical half. Otherwise similar to holotype.

PARATYPES: 7 males, 14 females. Body length of males 4.7–5.5 mm., of females 4.2–5.7 mm.; wing length of males 3.2–4.2 mm., of females 3.2–4.0 mm. Both sexes with third segment of antenna sometimes blackened at tip and outside; second and third bands of wing often definitely joined in discal cell. Otherwise essentially similar to holotype and allotype.

SPECIMENS: Holotype, ♂, Manhattan, Kans., June 15, 1932, C. W. Sabrosky (USNM 61857). Allotype, ♀, Manhattan, Kans., June 8, 1932, C. W. Sabrosky (USNM). Paratypes: IOWA: County 3 (1♀, June 22, 1936, D. Millspaugh; 1♀, 1♂, June 27, 1936, on same pin, D. Millspaugh; 1♀, June 26, 1936, Mabel Jaques; 1♀, June 27, 1936, D. Millspaugh; 2♀♀, 1♂, July 1, 1936, D. Millspaugh; 2♀♀, 2♂♂, July 1, 1936, M. E. Barnes). KANSAS: Clark County (1♀, June, "1,962 ft.," F. H. Snow); Saline County (1♀, June 7, 1933, C. W. Sabrosky). MINNESOTA: (1♂, Univ. Minn., No. 18, sub. 10); Olmsted County (1♀, 1♂, July 1904, on same pin. C. N. Ainslie). SOUTH DAKOTA: Brookings (1♀). TEXAS: Admore (1♀, Apr. 11, 1907, "on Salix," F. C. Bishopp); Harris County (1♀, Aug. 13, 1928, L. D. Beam); Victoria (1♀, Apr. 16, 1907, W. A. Hooker; 1♀, June 24, J. D. Mitchell). No data, 1♂. (In UM, ISC, CU, USNM, SEC, and CWS.)

REMARKS: The yellowish body color, the wing banding, and the male genitalia separate this species from other *Rivellia*.

*Rivellia pallida* Loew

FIGURE 3,*e-h*

*Rivellia pallida* Loew, 1873, p. 95, pl. 8, fig. 8.—Hendel, 1914a, p. 181.

TYPE LOCALITY: Washington, D. C. (MCZ).

MALES: Body length 3.5–4.5 mm.

Head: Frons yellow to brownish yellow; upper fronto-orbital plates concolorous with frons, ocellar triangle blackened. Face with dorsal half pruinose, ventral half shining, smooth, yellow to brownish yellow; parafacials and part of orbits ventral to each eye yellow to brownish yellow. Antenna with first and second segments yellow to brownish yellow; third segment blackened anteriorly or on outside, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with ventral portion of face. Palpi yellow. Posteranium yellow to brownish yellow, pruinose.

Thorax: Mesonotum yellow to brownish yellow; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura yellow to brownish yellow, mostly shining, pruinosity obscure except on laterotergite. Mesopleuron with scattered pale and black setae on posterior one-third; sternopleuron with few scattered pale setae on disc; pteropleuron with few scattered pale setae on disc, few black setae present ventral to subalar. Laterotergite completely pruinose. Prosternum yellow.

Thoracic appendages: All legs with coxae and femora yellow. All tibiae yellow or sometimes brownish. Front and hind tarsi wholly yellow or blackened from third or fourth segment; middle tarsi wholly yellow, blackened from third or fourth segment, or only fifth segment blackened.

Wing (fig. 3,*e*) length 2.5–3.5 mm. Bands black. First and second bands separated at costal margin; third and fourth bands narrowly joined at costal margin; second and third bands sometimes almost joined in discal cell. The part of first basal cell contiguous to second basal cell completely hyaline or faintly banded at base. Section of fourth vein proximad of anterior crossvein with slight bend. Halteres brownish yellow to brown.

Abdomen: Tergites shining, smooth, yellow, brownish yellow, or yellowish brown, sometimes with reddish or blackish blotches. Disc of first tergite with pale setae. Genitalia (fig. 3,*g,h*) with apical part of aedeagus longer than basal part, appearing appressed to basal part at base. From dorsal view, lateral margins of apical part rounded basally and gradually converging apically.



FEMALES: Since I cannot distinguish between the females of this species and *R. imitabilis*, only females collected by me in the same local population at the same time with the males of this species are considered: Body length 3.2–3.7 mm.; wing length 2.6–2.8 mm.; ovipositor sheath yellow at base, blackish toward apex. Otherwise similar to males.

SPECIMENS EXAMINED: MINNESOTA (28♀♀, 21 ♂♂): Sucker Lake (Ramsey County); June 24–July 24.

REMARKS: The males of this species can be separated from the other species by the wing banding, genitalia, and yellowish body color. Members of this species have been collected on *Amphicarpa bracteata* (L.) Fernald.

*Rivellia imitabilis*, new species

FIGURE 3,a-d

HOLOTYPE: Male. Body length about 3.9 mm.

Head: Frons yellowish brown; upper fronto-orbital plates concolorous with frons, ocellar triangle slightly blackened. Face with dorsal half pruinose, ventral half shining, smooth, pale yellow; parafacials and part of orbits ventral to each eye yellow. Antenna with first and second segments yellow; third segment blackened anteriorly, remainder yellow, the tip pointed anteriorly. Anteclypeus yellow. Palpi yellow. Postcranium pale brownish yellow, pruinose.

Thorax: Mesonotum brownish yellow; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura brownish yellow, mostly shining, pruinosity obscure except on laterotergite. Mesopleuron with scattered pale and black setae on posterior one-third; sternopleuron with few scattered pale setae on disc; pteropleuron with few scattered pale setae, few black setae present ventral to subalar. Laterotergite completely pruinose. Prosternum yellow.

Thoracic appendages: Coxae and femora of all legs yellow; front and middle tibiae yellow, hind tibiae brownish yellow; front tarsi blackened from fourth segment, remaining segments yellow, middle and hind tarsi with fifth segment blackened, remaining segments yellow.

Wing (fig. 3,a) length 3.1 mm., width 1.4 mm. Bands brown. First and second bands separated at costal margin; third and fourth bands narrowly joined at costal margin. The part of first basal cell contiguous to second basal cell completely hyaline. Section of fourth vein proximad of anterior crossvein with slight bend. Halteres light brown.

Abdomen: Tergites shining, smooth, yellowish brown toward base of abdomen, blackish toward tip. Disc of first tergite with pale setae. Genitalia (fig. 3,c,d) with apical part of aedeagus little shorter than basal part. From dorsal view apical part with lateral margins subparallel basally, converging apically.

PARATYPE: One male; body length about 3.2 mm.; wing length 3.0 mm., width 1.4 mm.; halteres with pedicel yellow, capitulum brown; fore tarsi blackened from third segment, middle tarsi with fifth segment blackened, hind tarsi blackened from fourth segment; first basal cell faintly banded at base; second and third bands joined in discal cell. Otherwise similar to holotype.

SPECIMENS: Holotype, ♂, Atlanta, Ga., June 27, 1933, P. W. Fattig (USNM 61919). Paratype: MICHIGAN: Marble Lake, Quiney (1 ♂, May 31, 1942, C. W. Sabrosky, CWS).

REMARKS: This species is very closely related to *R. pallida*. I cannot separate the females of the two species. The males can be separated by the genitalia. In *R. imitabilis* the apical part of the aedeagus is little shorter than the basal part and is not appressed to the basal part. In *R. pallida* the apical part is longer than the basal part and is appressed to the basal part at its base. *R. imitabilis* can be distinguished from other species by the wing banding, male genitalia, and the yellowish color of the body.

#### *Rivellia winifredae*, new species

FIGURE 9,c-g

HOLOTYPE: Male. Body length 5.2 mm.

Head: Frons reddish brown; upper fronto-orbital plates and ocellar triangle blackened. Face with little less than dorsal half pruinose; remainder shining, smooth, dark brown medioventrally, with yellowish brown lateral strip on each side which terminates just before oral margin; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments blackened on outside, inside yellow; third segment with tip and outside blackened, remainder yellow, tip pointed anteriorly. Anteclypeus concolorous with medioventral portion of face. Palpi yellowish brown. Postcranium black, pruinose.

Thorax: Mesonotum black; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura black, mostly shining. Mesopleuron with scattered, weak, pale setae on posterior half; pruinose area at dorsal posterior corner in form of right triangle, one side reaching half way to ventral posterior corner, the other side reaching half way to anterior spiracle. Sternopleuron with narrow pruinose strip

on ventral margin and a narrower strip on posterior margin; disc with scattered, weak, pale setae. Disc of pteropleuron with scattered, weak, pale setae, few black setae present ventral to subalar. Hypopleuron with shining disc, borders narrowly pruinose. Laterotergite completely and densely pruinose. Prosternum black.

Thoracic appendages: Front legs: Coxae with black spot on outside at base, remainder yellowish brown; femora with distal one-third of inside brownish yellow, remainder black; tibiae brownish yellow; tarsi blackened from second segment, first segment yellow. Middle legs: Coxae black; femora with distal one-third of outside brownish yellow, remainder black; tibiae yellowish at extreme tip, remainder black; tarsi slightly blackened from third segment, remaining segments yellow. Hind legs: Coxae, femora, and tibiae black; tarsi blackened from second segment, remaining segments yellow.

Wing (fig. 9,e) length 3.7 mm., width 1.6 mm. Bands dark brown. First and second bands narrowly separated at costal margin; third and fourth bands narrowly joined at costal margin. The part of first basal cell contiguous to second basal cell banded at base anteriorly, the hyaline area contiguous to fourth vein sharply wedgelike to base of second basal cell. Section of fourth vein proximad of anterior crossvein with definite bend. Halteres dark brown.

Abdomen: Tergites shining, rugose, black. Disc of first tergite with pale setae. Genitalia (fig. 9,g) with apical part of aedeagus consisting of a laterally flattened base bearing on the dorsum a sharp-pointed, curved, apically directed horn and two filamentous terminal tubes which are little longer than length of basal part of aedeagus.

ALLOTYPE: Female. Body length 5.5 mm.; wing length 4.2 mm., width 1.7 mm. Front femora with inside almost wholly brownish yellow; middle tibiae wholly brownish yellow. Ovipositor sheath black. Otherwise similar to holotype.

PARATYPES: 128 males, 166 females. Body length of males 4.3–6.2 mm., of females 4.5–6.3 mm.; wing length of males 3.5–4.3 mm., of females 3.7–4.5 mm. In both sexes general body color varies from brown to black; also in both sexes sometimes all legs wholly yellow or brownish yellow. Otherwise similar to holotype or allotype.

SPECIMENS: Holotype, ♂, Sucker Lake, Ramsey County, Minn., June 18, R. Namba (UM). Allotype, ♀, same data as the holotype. Paratypes: GEORGIA: Atlanta (1 ♀, Aug. 10, 1932, P. W. Fattig); Hiawassee (1 ♂, June 16, 1945, P. W. Fattig). ILLINOIS: Champaign (1 ♀, June 22, 1888, Marten-Hart, "14505"; 2 ♀♀, July 2, 1890, Marten-Hart, "15784"); Galena (1 ♀, June 29, 1892, Hart-Shiga, "18377"); Monticello (1 ♀, July 2, 1914); Parker (1 ♀, June 4, 1913). IOWA: Boone County, Ledges State Park (1 ♀, July 17, 1951, Jean

Laffoon); Lake Amana (1 ♂, June 23, 1928, G. O. Hendrickson); Linn County, Palisades-Kepler State Park (1 ♀, July 7, 1950, Laffoon, Slater, Hicks). KANSAS: Douglas County (1 ♂, "900 ft.," May); Lawrence (3 ♂♂, 1 ♀) (1 ♀, 1 ♂, J. M. Aldrich). MICHIGAN: Detroit (1 ♂, June 11, 1938, G. Steyskal). MINNESOTA: Mississippi Bluff, one-half mile north of state line, Houston County (1 ♂, May 30, 1941); Ramsey County (1 ♂, June 16, 1951; 85 ♀♀, 70 ♂♂, June 20, 1951; 1 ♀, 1 ♂, June 20, 1951, on same pin; 2 ♀♀, 1 ♂, June 25, 1951; 2 ♀♀, 3 ♂♂, June 29, 1951; 2 ♀♀, 1 ♂, July 2, 1951; 2 ♀♀, 1 ♂, July 18, 1951, all collected by R. Namba); St. Anthony Park, Ramsey County (49 ♀♀, 34 ♂♂, June 18, 1952, R. Namba; 8 ♀♀, 4 ♂♂, June 26, 1952); University Farm, Ramsey County (1 ♂, July 4, 1951, R. Namba); South Minneiska, John Latsch State Park (1 ♀, May 31, 1951, R. Namba). MISSISSIPPI: Utica (1 ♂, Aug.). NEW YORK: Ithaca (2 ♀♀, 1 ♂, July 9, 1904); Lancaster (1 ♀, June 4, 1911, and 1 ♂, June 8, 1912, M. C. Van Duzee). QUEBEC: Abbotsford (1 ♀, June 11, 1936, and 1 ♀, Aug. 24, 1936, G. Shewell); Farnham (1 ♂, July 16, 1935, G. Shewell). (In UM, GS, CU, USNM, SEC, CAS, AMNH, ISC, INHS, EU, and SCW.)

REMARKS: This species can be distinguished from the other *Rivellia* by the presence of strong humeral and posterior dorsocentral setae, the sharp wedgelike hyaline area in the first basal cell, and the male genitalia.

The members of this species were found abundantly on *Apios americana* Medic.

This species is affectionately dedicated to my wife Winifred.

### *Rivellia variabilis* Loew

FIGURE 9,a-d

*Rivellia variabilis* Loew, 1873, p. 91, pl. 8, fig. 6.—Hendel, 1914a, p. 181.—Cresson, 1924, p. 226.

TYPE LOCALITY: District of Columbia (MCZ).

MALES: Body length 4.2–6.0 mm., wing length 3.2–4.3 mm. Strong humeral setae present, posterior dorsocentral setae absent. Genitalia (fig. 9,c,d) with apical part of aedeagus consisting of an oblong base which from dorsal view has subparallel margins basally, converging little apically, from lateral view with dorsal margin angular, ventral margin relatively straight, and with two filamentous terminal tubes which are subequal in length to base. Otherwise, except for coloration, essentially similar to *R. winifredae*.

FEMALES: Body length 4.3–6.0 mm., wing length 3.5–4.6 mm.

VARIATIONS: As suggested by its name, this species is quite variable. The variation in general coloration is from yellow to pitch black.

Four general color forms can be separated. However, these categories are by no means distinctly delimited and individuals do exist which may be considered as intergrades between categories. Furthermore, there is no correlation between the color forms and their geographical distribution. The four color forms will be described separately here.

**YELLOW FORM:** Posteranium and thorax wholly yellowish. Legs yellow except for middle and hind tibiae which are sometimes brownish toward tip. Abdominal tergites vary from almost wholly yellow to almost wholly black.

**SPECIMENS EXAMINED:** GEORGIA (6 ♀ ♀, 2 ♂ ♂): Billy's Island (Okefenokee Swamp), Tifton; May 28–Aug. 11. FLORIDA (3 ♀ ♀, 1 ♂): Hillsborough County (Little Mantee River, U. S. Highway 41), Bradenton, Fort Myers; March 11–July 14. NORTH CAROLINA (2 ♀ ♀, 1 ♂): Raleigh, Everetts; June 11–Early August. NEW JERSEY (4 ♀ ♀, 1 ♂): Westfield, Angelsea, Elizabeth, Clementon; May 21–July 22. NEW YORK (1 ♀): Flushing; June 15. ILLINOIS (1 ♀): Cabin Boat (INHS); July 1.

**YELLOW-BROWN FORM:** Posteranium brown or dark brown. Mesonotum dark brown or black; pleura yellowish, sternopleuron sometimes brown. Legs yellowish except for middle and hind tibiae, which are brownish, and all tarsi, which are blackened toward tips. Abdominal tergites usually dark brown or black.

**SPECIMENS EXAMINED:** VIRGINIA (1 ♂): Great Falls; June 12. NEW YORK (8 ♀ ♀, 9 ♂ ♂): Babylon, Bronx, Maspeth, Riverhead, Mosholu, East Aurora, Orient, Oakdale; June 6–Aug. 12. MICHIGAN (1 ♀): Nottawa; Aug. 26.

**BROWN FORM:** Posteranium, thorax, and abdominal tergites concolorous, dark brown or black. Legs yellowish except for middle and hind tibiae which are brownish and all tarsi which are blackened toward tips.

**SPECIMENS EXAMINED:** GEORGIA (1 ♀, 1 ♂): Griffin; Aug. 12. NEW YORK (5 ♀ ♀, 2 ♂ ♂): Flushing, Babylon, East Aurora, Oakdale; June 3–July 22. NEW JERSEY (1 ♀): West Orange; Sept. MICHIGAN (1 ♀): Gratiot County; June 17.

**BLACK FORM:** Posteranium, thorax, and abdominal tergites concolorous, dark brown or black. Front legs: Coxae wholly yellow or with brown spot on outside at base; femora wholly yellow or yellow inside and black outside; tibiae blackish toward base, yellowish toward tip; tarsi yellow toward base, blackened toward tip. Middle and hind legs: Coxae, femora, and tibiae black; tarsi yellow toward base, blackened toward tip.

**SPECIMENS EXAMINED:** GEORGIA (2 ♀ ♀, 9 ♂ ♂): Atlanta, Griffin, Adel; May 21–Aug. 12. NORTH CAROLINA (4 ♀ ♀, 1 ♂): Raleigh,

Swannanoa; July 10–Aug. 16. VIRGINIA (2 ♀ ♀, 1 ♂): Great Falls; June 12. NEW JERSEY (1 ♀, 1 ♂): Westfield, West Orange; June 18–Sept. OHIO (1 ♀, 1 ♂): Summit County; June 19–28. PENNSYLVANIA (1 ♀): Lehigh Gap; July 9. NEW YORK (16 ♀ ♀, 12 ♂ ♂): Ithaca, Babylon, Mosholu, Bronx, Pocantico Hills, Flushing, Olcott, Buffalo; June 9–Aug. 5. MASSACHUSETTS (2 ♀ ♀, 5 ♂ ♂): East Gloucester, Boston, Woods Hole; June–Aug. 3. QUEBEC (2 ♀ ♀, 3 ♂ ♂): Abbotsford; Aug. 24. MICHIGAN (21 ♀ ♀, 15 ♂ ♂): East Lansing, Huron County, Ionia County, Midland County, Cheboygan County, Genesee County, Gratiot County, Deerfield Township (Lapeer County), Detroit, Hamburg, Douglas Lake, Mecosta County, Montcalm County, Muskegon County, Oakland County, Wexford County; June 11–July 15. ONTARIO (2 ♀ ♀, 1 ♂): Britannia, Leamington; June 10–July 23. MINNESOTA (1 ♀, 3 ♂ ♂): Sucker Lake, Ramsey County; June 18–20.

One character which separates this species from all other *Rivellia* is the presence of strong humeral setae and the absence of the posterior dorsocentral setae.

*Rivellia cognata* Cresson

FIGURE 10, *i-l*

*Rivellia cognata* Cresson, 1919, p. 191; 1924, p. 228.

TYPE LOCALITY: Swarthmore, Pa. (ANSP).

MALES: Body length 2.8–4.5 mm.

Head: Frons reddish brown or brown; upper fronto-orbital plates and ocellar triangle blackened. Face with dorsal half pruinose, ventral half shining, smooth, dark brown or almost black; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments brownish yellow; third segment with tip, outside, and anterior side of inside blackened, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with ventral portion of face. Palpi brownish yellow or brown. Posteranium dark brown or black, pruinose.

Thorax: Mesonotum dark brown or blackish blue; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura dark brown or black, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of a right triangle, one side reaching two-thirds distance to ventral posterior corner and the other side reaching two-thirds distance to anterior spiracle. Sternopleuron with a narrow pruinose strip on ventral corner and a narrower strip on posterior margin; disc with few scattered pale setae. Disc of pteropleuron with scattered pale setae, black setae present or absent ventral to subalar. Hypopleuron with shining central spot, remainder

pruinose. Laterotergite completely and densely pruinose. Prosternum dark brown or black.

Thoracic appendages: Front legs: Coxae, femora, and tibiae yellow; tarsi blackened from fourth segment, remaining segments yellow. Middle legs: Coxae with brown spot on outside at base; femora and tibiae yellow; tarsi with fifth segment blackened, remaining segments yellow. Hind legs: Coxae and femora yellow; tibiae vary from brownish yellow to almost black; tarsi slightly blackened from fourth segment, remaining segments yellow.

Wing (fig. 10,i) length 2.4–3.4 mm. Bands black. First and second bands widely separated at costal margin; third and fourth bands joined at costal margin. Second band definitely oblique to costal margin. The part of first basal cell contiguous to second basal cell entirely hyaline or at most faintly banded basally. Section of fourth vein proximad of anterior crossvein with slight bend. Halteres yellowish brown or dark brown.

Abdomen: Tergites shining, rugose, brown or black. Disc of first tergite with pale setae. Genitalia (fig. 10,k,l) with apical part of aedeagus wedge-shaped, the two terminal tubes little longer than the base of apical part.

FEMALES: Body length 3.0–5.1 mm.; wing length 2.4–3.2 mm. Ovipositor sheath concolorous with abdomen. Otherwise similar to males.

SPECIMENS EXAMINED: DISTRICT OF COLUMBIA (2♀♀): Rock Creek; June 15. GEORGIA (1♀): Atlanta; June 8. ILLINOIS (4♀♀, 8♂♂): Algonquin; no date. INDIANA (3♀♀): La Fayette; July 3–12. IOWA (19♀♀, 10♂♂): Ames, County 3, County 64, County 76, Des Moines, Ledges State Park, Palisades-Kepler State Park, Sioux City; May 25–July 31. KANSAS (1♀): Douglas County; June. MARYLAND (4♀♀): Cabin John Br.; June 14–28. MICHIGAN (2♀♀, 1♂): Ionia County, Monroe; July 4–12. MINNESOTA (52♀♀, 29♂♂): St. Paul Water Works (Anoka County), Gray Cloud Island, Hammond, Mississippi Bluff one-half mile north of state line (Houston County), Owatonna, St. Anthony Park (Ramsey County), Sucker Lake, University Farm, Winona County; June 1–Aug. 3. MISSOURI (1♀): Shrewsbury (?); Aug. 6. NEBRASKA (1♀): No data. NEW JERSEY (2♀♀): Trenton; July 6. NEW YORK (9♀♀, 7♂♂): East Aurora, Flatbush, Irving, Ithaca, Lancaster, Rome; May 27–Aug. 19. NORTH CAROLINA (2♀♀): Valley of Black Mountains; July 10. OHIO (4♀♀, 1♂): Summit County; July 29–Aug. 11. PENNSYLVANIA (15♀♀, 7♂♂): Delaware County, Kempton, Manayunk, Philadelphia, Swarthmore; May 21–Aug. 13. RHODE ISLAND (1♂): Westerly; June 29. SOUTH DAKOTA (1♂): Brookings; no date. TENNESSEE (1♀): Clarksville; July 4. VIRGINIA (3♀♀): Great Falls, Rosslyn; June 3–25.

*Rivellia vaga*, new speciesFIGURE 1, *d-f*

HOLOTYPE: Male. Body length about 3.3 mm.

Head: Frons yellowish brown; upper fronto-orbital plates and ocellar triangle blackened. Face with dorsal half pruinose, ventral half shining, smooth, yellowish brown; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments yellow inside, blackened outside; third segment blackened at tip and on outside, remainder yellow, the tip pointed anteriorly. Anteclypeus dark brown. Palpi yellow. Posteranium black, pruinose.

Thorax: Mesonotum black; strong humeral and posterior dorso-central setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura dark brown, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose spot at dorsal posterior corner in form of rectangle, one side extending two-thirds distance to ventral posterior corner, the other side extending about half way to anterior spiracle. Sternopleuron with ventral corner pruinose; disc with few scattered pale setae. Disc of pteropleuron with few scattered pale setae, one black seta present ventral to subalar. Hypopleuron with small shining central spot, remainder pruinose. Laterotergite pruinose. Prosternum black.

Thoracic appendages: Legs wholly yellow except for fore tarsi which are blackened from third segment.

Wing (fig. 1, *d*) length 2.2 mm., width 0.9 mm. Bands dark brown. First and second bands separated at costal margin, slightly oblique to costal margin; first band does not enter discal cell, ends at fourth vein. Third band perpendicular to costal margin. Third and fourth bands very narrowly joined at costal margin; fourth band greatly broadened at tip of third vein. The part of first basal cell contiguous to second basal cell faintly banded at basal half. Section of fourth vein proximad of anterior crossvein with very slight bend. Halteres brownish yellow.

Abdomen: Tergites shining, slightly rugose; first three tergites brownish, remainder black. Disc of dorsum of first tergite with pale setae. Genitalia (fig. 1, *f*) with apical part of aedeagus consisting of a cone-shaped base bearing on the dorsum a blunt horn, and two filamentous terminal tubes which are subequal in length to basal part of aedeagus.

ALLOTYPE: Female. Body length about 3.6 mm.; wing length 2.5 mm., width 1.0 mm. Legs wholly yellow. Abdominal tergites dark brown except for two large yellowish lateral spots on second tergite and two smaller yellowish lateral spots on third tergite; ovipositor sheath dark brown. Otherwise similar to holotype.



PARATYPES: 73 males, 107 females. Body length of males 2.5–3.7 mm., of females 2.7–3.2 mm.; wing length of males 2.0–2.4 mm., of females 2.0–3.2 mm. Both sexes with thorax and abdominal tergites sometimes brown; tarsi of front legs sometimes wholly yellow; fourth band sometimes separated from third band at costal margin. Abdomen of males usually with first three tergites, sometimes fourth also, brownish yellow or yellowish brown; in females usually unicolorous, dark brown or black. Otherwise essentially similar to holotype or allotype.

SPECIMENS: Holotype, ♂, Elfers, Fla., July 14, 1939, D. E. Hardy (SEC). Allotype, ♀, same data as holotype. Paratypes: ALABAMA: Cowarts (1 ♀, Aug. 1–3, 1916, No. "Ac. 4898"); Elgin (1 ♀, July 6, 1939, A. T. Hardy; 1 ♀, July 6, 1939, D. E. Hardy); Garden City (1 ♀, July 7, 1939, A. T. Hardy; 2 ♂♂, July 7, 1939, R. H. Beamer; 1 ♂, July 7, 1939, P. B. Lawson); Montgomery (1 ♀, July 7, 1939, D. E. Hardy). CANADA: Watertown Lake Park, Alberta (2 ♂♂, July 26, 1946, C. E. Mickel). FLORIDA: Branford (1 ♀, Aug. 4, 1939, A. T. Hardy; 1 ♀, 1 ♂, Aug. 4, 1939, D. E. Hardy); Cedar Keys (2 ♀♀, 1 ♂, July 12, 1939, Oman; 1 ♀, July 12, 1939, R. H. Beamer; 5 ♀♀, 8 ♂♂, July 12, 1939, A. T. Hardy; 8 ♀♀, 4 ♂♂, July 12, 1939, J. D. Beamer; 3 ♀♀, July 12, 1939, P. B. Lawson; 3 ♀♀, 4 ♂♂, July 12, 1939, D. E. Hardy; 6 ♀♀, 1 ♂, Aug. 10, 1939, A. T. Hardy; 1 ♀, Aug. 10, 1939, D. E. Hardy); Coconut Grove (1 ♀, Aug. 9, 1930, J. Nottingham); Dunnellon (1 ♀, July 12, 1939, P. B. Lawson); Elfers (3 ♀♀, 1 ♂, July 14, 1939, D. E. Hardy); Gainesville (1 ♀, Sept. 26–Oct. 2, 1914); Hilliard (1 ♂, Aug. 19, 1930, R. H. Beamer; 1 ♂, July 24, 1939, D. E. Hardy; 1 ♀, 2 ♂♂, Aug. 6, 1939, R. H. Beamer); Hobe Sound (1 ♀, July 21, 1939, D. E. Hardy); Hudson (1 ♂, July 13, 1939, R. H. Beamer; 2 ♂♂, July 13, 1939, D. E. Hardy); Labelle (1 ♀, July 16, 1939, P. B. Lawson; 1 ♂, July 16, 1939, D. E. Hardy); Lacoochee (1 ♀, Aug. 9, 1939, D. E. Hardy); Marianna (1 ♀, Aug. 11–18, 1938, "Bishopp lot, Sabrosky No. B 959"); Miami (1 ♂, Nov. 5, 1911); Monticello (1 ♀, Oct. 4–8, 1914); New Smyrna Beach (2 ♀♀, June 6, 1942, D. G. Denning); Old Town (2 ♂♂, July 11, 1939, D. E. Hardy); Sanford (1 ♀, 1 ♂, Aug. 4, 1930, J. Nottingham; 5 ♀♀, Aug. 8, 1939, R. B. Beamer; 4 ♂♂, Aug. 8, 1939, A. T. Hardy); Suwanee Springs (1 ♀, 1 ♂, July 29, 1930, J. Nottingham; 1 ♀, Aug. 2–3, 1939, D. E. Hardy); Waldo (1 ♀, Aug. 18, 1930, J. Nottingham; 1 ♀, 1 ♂, Aug. 18, 1930, R. H. Beamer); Wakulla (1 ♀, July 10, 1939, R. H. Beamer; 5 ♀♀, 3 ♂♂, July 10, 1939, D. E. Hardy); Winter Park (1 ♂, May 26, 1937, R. Dow); Zolfo Springs (2 ♀♀, 2 ♂♂, July 15, 1939, D. E. Hardy; 2 ♀♀, July 15, 1939, A. T. Hardy). GEORGIA: (2 ♀♀, Cornell Univ. Lot 60, Sub. 31); Southern Georgia (1 ♂, Morrison); Adel

(2♂♂, Aug. 11, 1939, J. D. Beamer); Billy's Island, Okefenokee Swamp (1♂, June, 1912); Griffin (14♀♀, 8♂♂, Aug. 12, 1939, A. T. Hardy; 3♀♀, Aug. 12, 1939, J. D. Beamer; 3♀♀, 2♂♂, Aug. 12, 1939, R. H. Beamer; 4♀♀, 4♂♂, Aug. 12, 1939, E. G. Wegenek); Perry (1♂, Aug. 12, 1939, R. H. Beamer; 1♂, Aug. 12, 1939, D. E. Hardy); Tifton (1♀, Sept. 3, 1896, W. M. Wheeler; 1♀, Aug. 11, 1939, D. E. Hardy). IOWA: Mount Pleasant (1♀, June 5, 1940, H. Knutson). KANSAS: Lawrence (1♂, Aug. 22, 1939, D. E. Hardy); Sedgwick County (1♂, 1916, "1,291 ft.," R. H. Beamer). LOUISIANA: Red River Park (1♀, Aug. 17, 1928, E. I. Beamer). NORTH CAROLINA: Asheville (1♀, Aug. 1, 1933, Wray); Franklin (2♀♀, Aug. 17, 1939, D. E. Hardy); Goldsboro (1♂, July 20, 1946, M. W. Wing); Lumberton (1♂, June 22, 1928, T. B. Mitchell); Raleigh (1♀, early August, 1912, C. L. Metcalf). SOUTH CAROLINA: Fairfax (1♀, June 5, 1933, E. W. Howe). TEXAS: Galveston (2♀♀, June 5, 1900, W. M. Wheeler). (In SEC, NC, UM, USNM, AMNH, CU, and CWS.)

REMARKS: This species is closely related to *R. maculosa*, from which it can be distinguished by the male genitalia and full banding of the wings. Frequently in this species (especially males) the anterior tergites of the abdomen are yellowish, whereas in *R. maculosa* the abdominal tergites are wholly dark brown or black.

*Rivellia texana*, new species

FIGURE 5,f-i

HOLOTYPE: Male. Body length about 3.6 mm.

Head: Frons brown, somewhat yellowish toward antenna; upper fronto-orbital plates and ocellar triangle little darker than frons. Face with dorsal half pruinose, ventral half shining, smooth, brown; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments yellow; third segment blackened at tip and on outside, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with ventral portion of face. Palpi yellow. Postcranium dark brown, pruinose.

Thorax: Mesonotum dark brown; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura dark brown, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of rectangle, one side extending two-thirds distance to ventral posterior corner, the other extending about half way to anterior spiracle. Sternopleuron with pruinose spot covering

ventral corner, a pruinose medial band extending from this spot to dorsal margin of sternopleuron; disc with few scattered pale setae. Disc of pteropleuron with few scattered pale setae, one black seta present ventral to subalar. Hypopleuron with small shining central spot, remainder pruinose. Laterotergite completely and densely pruinose. Prosternum dark brown.

Thoracic appendages: Legs wholly yellow.

Wing (fig. 5,f) length 2.4 mm. Bands dark brown. First and second bands separated at costal margin, slightly oblique to costal margin; first band does not enter discal cell, ends at fourth vein. Third band perpendicular to costal margin, broadened at third vein. Fourth band consists of spot at tip of third vein, not connected to third band. The part of first basal cell contiguous to second basal cell very faintly banded at basal half. Section of fourth vein proximad of anterior crossvein with very slight bend. Halteres brown.

Abdomen: Tergites shining, slightly rugose, black. Disc of first tergite with pale setae. Genitalia (fig. 5,h,i) with apical part of aedeagus bearing a horn on dorsum of base, a flattened finlike structure laterally on each side of base, and two short filamentous terminal tubes.

ALLOTYPE: Female. Body length about 3.9 mm.; wing length 3.0 mm., width 1.7 mm. Frons brownish yellow. Hind tibiae brownish yellow. Front tarsi blackened slightly from third segment, hind tarsi with fifth segment slightly blackened. Third band of wing not broadened conspicuously at third vein. Abdominal tergites and ovipositor sheath dark brown. Otherwise similar to holotype.

PARATYPES: 24 males, 14 females. Body length, males and females, 3.2–4.2 mm.; wing length, males 2.4–3.0 mm., females 2.4–3.3 mm. In both sexes thorax and abdominal tergites sometimes black; sternopleuron sometimes without medial pruinose band; fourth band sometimes narrowly joined to third band at costal margin. Otherwise essentially similar to holotype or allotype.

SPECIMENS: Holotype, ♂, College Station, Tex., Apr. 21, 1943, H. J. Reinhard (TAM). Allotype, ♀, same data as holotype. Paratypes: ARKANSAS: Fayetteville (1 ♂, June 22, 1907). TEXAS: College Station (2 ♂♂, May 14, 1923; 1 ♂, May 3, 1931; 4♀♀, 4 ♂♂, Apr. 21, 1932; 2♀♀, 5 ♂♂, May 1, 1932; 1 ♂, Apr. 13, 1943; 5♀♀, 6 ♂♂, Apr. 21, 1943; 1 ♂, Apr. 30, 1943; 1♀, May 1, 1947; 1♀, May 7, 1947; 2 ♂♂, May 15, 1947; 1♀, 1 ♂, May 11, 1947, on same pin; all collected by H. J. Reinhard). (Deposited in TAM, CU, USNM, and UM.)

REMARKS: This species appears to be related to *R. maculosa* and *R. vaga*. Its full wing banding, which is similar to that of *R. vaga*,

easily distinguishes it from *R. maculosa*. The males of *R. texana* can be easily distinguished from those of *R. vaga* by the genitalia. The notable difference is the presence in *R. texana* and the absence in *R. vaga* of lateral finlike structures on the apical part of the aedeagus. I am not able to separate the females of these two species in all cases. *R. texana* females are generally larger, the fourth band of the wings usually is not connected to the third band at the costal margin, the sternopleuron usually with a medial pruinose band, and the abdominal tergites are dark brown or black. *R. vaga* females are usually smaller, the fourth band of wing is usually narrowly connected to the third band at costal margin, sternopleuron without medial pruinose band, and abdominal tergites sometimes yellowish anteriorly.

*Rivellia micans* Loew

FIGURE 10, a-d

*Rivellia micans* Loew, 1873, p. 94—Van Der Wulp, 1898, p. 382, pl. 10, fig. 9.—Hendel, 1914a, p. 181.—Cresson, 1924, p. 228.

TYPE LOCALITY: Texas (MCZ).

MALES: Body length 3.1–5.0 mm.

Head: Frons reddish brown or yellowish brown; upper fronto-orbital plates and ocellar triangle blackened. Face with dorsal half pruinose, ventral half shining, smooth, brown or dark brown medioventrally, with brownish yellow lateral strip on each side which terminates just before oral margin; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments yellow; third segment with tip, outside, and anterior side of inside blackened, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with medioventral portion of face. Palpi brown with yellow borders or wholly brownish yellow. Posteranium blackish green, pruinose.

Thorax: Mesonotum blackish green; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura dark brown or blackish green, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of a right triangle, one side reaching halfway to ventral posterior corner and the other side reaching halfway to anterior spiracle. Sternopleuron with ventral corner and very narrow strip on posterior margin pruinose; disc with scattered pale setae. Disc of pteropleuron with scattered pale setae, black setae present or absent ventral to subalar. Hypopleuron with shining central spot, remainder pruinose. Laterotergite completely and densely pruinose. Prosternum black.

Thoracic appendages: Front Legs: Coxae, femora, and tibiae yellow; tarsi slightly blackened from second segment or from tip of first segment, remaining segments yellow. Middle legs: Coxae brown; femora and tibiae yellow; tarsi wholly yellow or slightly blackened from fourth segment. Hind legs: Coxae yellowish brown; femora yellow; tibiae yellow or brown; tarsi wholly yellow or blackened from third segment.

Wing (fig. 10,*a*) length 2.6–3.6 mm. Bands dark brown. First and second bands widely separated at costal margin; third and fourth bands joined at costal margin, fourth band narrow, about as broad as third band. Second band appears almost perpendicular to costal margin. The part of first basal cell contiguous to second basal cell wholly banded, with semicircular hyaline spot anterior to apex of second basal cell, or faintly banded at base. Section of fourth vein proximad of anterior crossvein with bend. Halteres yellowish brown or brown.

Abdomen: Tergites shining, rugose, wholly blackish green, wholly brownish yellow, or anterior tergites yellowish and posterior tergites blackish, the extent of each color rather variable. Disc of first tergite with pale setae. Genitalia (fig. 10,*c,d*) with apical part of aedeagus consisting of a bulbous base and two filamentous terminal tubes which are at least as long as the bulbous base.

FEMALES: Body length 3.5–5.0 mm.; wing length 2.5–3.8 mm. Pruinoso triangle on mesopleuron more distinct. Abdominal tergites usually unicolorous, blackish green; if bicolorous, yellowish color extends to posterior margin of third tergite. Otherwise similar to males.

SPECIMENS EXAMINED: ARIZONA (25♀♀, 25♂♂): Chiricahua Mts. (Rustler Park), Huachuca Mts. (Sunnyside Canyon), Lakeside, Santa Rita Mts.; Apr. 7–Aug. 7. CALIFORNIA (9♀♀, 13♂♂): Bishop, Boulevard, Jacumba; July 5–28. COLORADO (1♂): Lyons; July 9. ILLINOIS (2♂♂): Metropolis, Olney; May 29–Aug. 5. IOWA (1♀, 8♂♂): Ames, 8 miles southeast of Britt, County 3, Des Moines (Polk County), 7 miles northwest of Thompson, Sioux City (South Ravine), 5 miles south of Stanhope; June 15–Aug. 25. KANSAS (12♀♀, 39♂♂): Clark County, Coffey County, Cowley County, Douglas County, Cove County, Harper County, Hodgeman County, Inman, Lyons County, Manhattan, McPherson County, Medora Sand Dunes, Miami County, Montgomery County, Ottawa County, Saline County, Sedgwick County, Stark; May 22–Aug. 31. MONTANA (1♀): No data. NEBRASKA (1♀): No data. NEW MEXICO (1♀, 3♂♂): Albuquerque, Las Cruces; June 4–July 3. SOUTH

DAKOTA (1♀, 1♂): Elk Point, 3 miles south of Jefferson; June 11-20. TEXAS (1♂): Glen Rose; May 19.

REMARKS: This species is closely related to *R. severini*.

*Rivellia severini* Blanton

FIGURE 10,c-h

*Rivellia severini* Blanton, 1937, p. 139, fig. 1.

TYPE LOCALITY: Winner, S. Dak. (USNM 51444).

MALES: Body length 3.5-5.0 mm. Wing (fig. 10,e) length 2.6-3.5 mm. Fourth band broad, width at tip of third vein equal to or longer than length of posterior crossvein. Hind tibiae brown to almost black. Genitalia (fig. 10,g,h) with apical part of aedeagus consisting of a bulbous base and two filamentous terminal tubes which are definitely shorter than length of bulbous base. Otherwise similar to *R. micans*.

FEMALES: Body length 3.8-4.7 mm., wing length 2.8-3.5 mm.

SPECIMENS EXAMINED: COLORADO (7♀♀, 13♂♂): Las Animas, Lyons, Maybell, Valmont (White Rocks); June 17-July 9. IDAHO (2♀♀, 3♂♂): Bliss, Burley; June 6-July 7. IOWA (13♀♀, 5♂♂): County 3; June 15-July 3. KANSAS (1♀, 1♂): Douglas County, Hamilton County; no date. MANITOBA (8♀♀, 4♂♂): Aweme; July 1-28. NEBRASKA (4♀♀, 2♂♂): Valentine; June 9-11. SOUTH DAKOTA (5♀♀, 8♂♂): Brookings, Canton, Elk Point, Lake Andes, Newell, Winner; June 12-July 4. UTAH (2♀♀, 4♂♂): Antimony, Hooper, Midvale, Provo, Spanish Fork, Woods Cross; June 10-Aug. 1. WYOMING (4♀♀, 8♂♂): Bull Lake, Laramie, Little Wing, Lusk, Sage Creek; July-Sept. 4.

REMARKS: This species is closely related to *R. micans*, from which it can be distinguished by the broader fourth band, usually darker hind tibiae, and the shorter terminal tubes of the apical part of the aedeagus.

*Rivellia flavimana* Loew

FIGURE 4,i,j

*Rivellia flavimana* Loew, 1873, p. 92, pl. 8, fig. 7.—Hendel, 1914a, p. 177.—Cresson, 1924, p. 227.

TYPE LOCALITY: Nebraska (MCZ).

Body length, males, 3.0-4.8 mm.; females, 3.5-5.0 mm.

Head and thorax: Similar to *R. metallica*.

Thoracic appendages: Front legs: Coxae, femora, and tibiae yellow; tarsi blackened from third or fourth segment, remaining segments yellow. Middle legs: Coxae black; femora yellowish at extreme tip, remainder black; tibiae slightly blackened at base, yellowish toward tip; tarsi wholly yellow or only fifth segment slightly

blackened. Hind legs: Coxae black; femora and tibiae yellowish at extreme tip, remainder black; tarsi blackened from fourth segment, remaining segments yellow.

Wing (fig. 4,*i*) length: Males 2.5–3.4 mm., females 2.6–3.4 mm. Bands dark brown or black, not as narrow as those of *R. metallica*. First and second bands narrowly separated at costal margin; third and fourth bands narrowly joined at costal margin. Costal cell banded; the part of first basal cell contiguous to second basal cell completely hyaline or at most very faintly banded basally. Section of fourth vein proximad of anterior crossvein with slight bend.

Abdomen: Tergites rugose; otherwise similar to those of *R. metallica*. Aedeagus similar to that of *R. metallica*; however, apices of surstyli (fig. 4,*j*) different in shape from lateral view. Ovipositor sheath concolorous with abdominal tergites.

SPECIMENS EXAMINED: CONNECTICUT (1♂): AVON; June 21. ILLINOIS (4♀♀, 7♂♂): ALGONQUIN, no date; MONTICELLO, June 21. IOWA (5♀♀): AMES, Britt, County 3; May 31–June 19. MANITOBA (1♀, 2♂♂): AWEME, Dauphin, Holland; June 18–July 14. MICHIGAN (36♀♀, 26♂♂): Bay County, Cheboygan County, Clinton County, Detroit, East Lansing, Grand Rapids, Gratiot County, Ionia County, Lapeer County, Midland County, Monroe, Nottawa, Rose Lake, Saginaw County; May 21–Aug. 13. MINNESOTA (388♀♀, 223♂♂): ANOKA County, Chisago County, Cushing (Fish Trap Lake), Fort Snelling, Highway 26, 3 miles northeast of Eitzen (Houston County), Highway 26, 3 miles north of Hokah (Houston County), Mississippi Bluff, one-half mile north of state line (Houston County), Itasca State Park, Kanabec County, Kittson County, Lake Minnetonka, Lake Vadnais, Laporte, Middle River, Norman County, Olmstead County, mouth of Snake River (Pine County), Plummer, Oak Forest, Snail Lake, St. Anthony Park, Sucker Lake, University Farm, Washington County, White Bear; Mar. 9–Aug. 9. NEW HAMPSHIRE (1♂): Center Harbor; July. NEW JERSEY (4♀♀): Brookside (Morris County), Newfoundland, Ramsey; May 28–July 6. NEW YORK (19♀♀, 10♂♂): Canajoharie, Charlotte, Flatbush (Long Island), Ithaca, Jamaica (Long Island), Lancaster, Mosholu, Pocantico Hills, Rome, Tuxedo (Station for Study of Insects); May 30–July 15. OHIO (1♂): Summit County; June 9. ONTARIO (27♀♀, 21♂♂): Ancaster, Centreville, Gananoque, Jordan, Normandale, Orillia, Ottawa, Simcoe, Tillsonburg, Toronto, Vineland; June 7–July 22. QUEBEC (42♀♀, 22♂♂): Abbotsford, Aylmer (Queens Park), Chambly County, Fairy Lake, Hull, Ile de Montreal, Missisquoi Bay, Rouville County, St. Johns County, Wakefield; May 1–Aug. 24. SOUTH DAKOTA (1♂): Brookings.

REMARKS: Members of this species are abundantly found on hog-peanut (*Amphicarpa bracteata* (L.) Fernald).

*Rivellia michiganensis*, new species

FIGURE 4,*a-d*

HOLOTYPE: Male. Body length about 4.0 mm.

Head: Frons dark reddish brown; upper fronto-orbital plates and ocellar triangle black. Face with dorsal half pruinose, ventral half shining, smooth, black; parafacials and part of orbits ventral to each eye brownish yellow. Antenna long, definitely surpassing oral margin; with first and second segments yellowish brown; third segment almost entirely black, only a narrow posterior strip on inside brownish yellow, the tip rounded, from lateral view somewhat constricted before tip. Anteclypeus black. Palpi brown. Posteranium black, pruinose.

Thorax: Mesonotum black; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura black, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of right triangle, one side reaching two-thirds distance to ventral posterior corner and the other side reaching two-thirds distance to anterior spiracle. Sternopleuron with narrow pruinose strip on ventral margin and a narrower strip on posterior margin; disc with scattered pale setae. Disc of pteropleuron with scattered pale setae, one black seta present ventral to subalar. Hypopleuron with disc shining, borders narrowly pruinose. Laterotergite completely and densely pruinose. The prosternum cannot be seen in the type.

Thoracic appendages: Front legs: Wholly yellow. Middle legs: Coxae and femora black; tibiae with somewhat less than basal half black, remainder yellowish; tarsi yellow. Hind legs: Coxae, femora, and tibiae black; tarsi yellow.

Wing (fig. 4,*a*) length 2.9 mm., width 1.4 mm. Bands black. First and second bands widely separated at costal margin; third and fourth bands definitely separated at costal margin. Fourth band broad, width at tip of third vein subequal to length of posterior crossvein. The part of first basal cell contiguous to second basal cell completely hyaline. Section of fourth vein proximad of anterior crossvein with slight bend. Halteres with pedicel brownish yellow, capitulum dark brown.

Abdomen: Tergites shining, rugose, black. Disc of first tergite with pale setae. Genitalia (fig. 4,*c,d*) with apical part of aedeagus consisting of, from lateral view, a heart-shaped base and two filamentous terminal tubes which are subequal in length to length of basal



part of aedeagus. The apical part not appressed to basal part of aedeagus.

PARATYPE: Male. Body length about 3.5 mm.; wing length 2.5 mm. This specimen is covered with glue, but enough can be seen (including aedeagus) to show that it is conspecific with the holotype.

SPECIMENS: Holotype, ♂, Midland County, Mich., June 23, 1950, R. R. Dreisbach (USNM 61918). Paratype: MICHIGAN: Midland County (1 ♂, June 25, 1950, R. R. Dreisbach, RRD).

REMARKS: This species appears to be related to *R. flavimana*, from which the males can be distinguished by the elongated and round-tipped third segment of the antenna, broad fourth band of the wings, and the male genitalia.

*Rivellia melliginis* (Fitch)

FIGURE 5,a-c

*Tephritis melliginis* Fitch, 1855, p. 65.

TYPE LOCALITY: New York (USNM).

MALES: Body length 4.0–6.0 mm.

Head: Frons brown to reddish brown; upper fronto-orbital plates and ocellar triangle blackened. Face with dorsal half pruinose, ventral half shining, smooth, dark brown or black medioventrally, with brownish yellow lateral strip on each side which terminates just before oral margin; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments yellow or brownish yellow; third segment with tip and outside blackened, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with medioventral portion of face. Palpi brown or black, sometimes yellowish at base. Posteranium blackish blue, pruinose.

Thorax: Mesonotum blackish blue; strong humeral and posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura blackish blue, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of right triangle, one side reaching half way to ventral posterior corner and the other side reaching half way to anterior spiracle. Sternopleuron with narrow pruinose strip on ventral margin and a much narrower strip on posterior margin; disc with few scattered pale setae. Disc of pteropleuron with scattered pale setae, one or two black setae present ventral to subalar. Hypopleuron with shining central spot, remainder pruinose. Laterotergite completely and densely pruinose. Prosternum black.

Thoracic appendages: Front legs: Coxae dark brown or black, sometimes yellowish toward tip; femora black with extreme tip yel-

lowish; tibiae black basally, yellowish toward tip; tarsi blackened from second segment, remaining segments yellow. Middle legs: Coxae black; femora black, extreme tip sometimes yellowish; tibiae black, sometimes yellowish toward tip; tarsi blackened from third segment, remaining segments yellow. Hind legs: Coxae, femora, and tibiae black; tarsi blackened from third segment, remaining segments yellow.

Wing (fig. 5,a) length 3.4–4.0 mm. Bands black. First and second bands separated at costal margin; third and fourth bands narrowly joined at costal margin. The part of first basal cell contiguous to second basal cell with basal two-thirds banded, with semi-circular hyaline spot anterior to apex of second basal cell. Section of fourth vein proximad of anterior crossvein with definite bend. Halteres yellowish brown.

Abdomen: Tergites shining, rugose, blackish blue. Disc of first tergite with pale setae. Genitalia (fig. 5,c) with apical part of aedeagus consisting of a bulbous base and two long filamentous terminal tubes about three times the length of basal part of aedeagus; cerci extend beyond proctiger by about the length of proctiger.

FEMALES: Since I cannot distinguish between the females of this species and *R. viridulans*, only females collected by me in the same local population at the same time with the males of this species are considered: Body length 4.0–5.5 mm.; wing length 3.6–4.4 mm.; ovipositor sheath black. Otherwise similar to males.

SPECIMENS EXAMINED: DISTRICT OF COLUMBIA (1♂): Anacostia; May 13. GEORGIA (2♂♂): Neel Gap (Yonah Mountain); June 5–10. ILLINOIS (2♂♂): Meredosia; May 28. IOWA (2♂♂): Ames, Ledges State Park; May 26–June 19. MICHIGAN (1♀, 3♂♂): Mendon, Nottawa, northwestern Branch County, Leelanau County, Muskegon County; May 28–Aug. 2. MINNESOTA (12♀♀, 13♂♂): Olmsted County, St. Paul (University Farm); May 26–June 29. NEW JERSEY (5♂♂): Alpine, Trenton, Wenonah; June 8–24. NEW YORK (42♂♂): Babylon (Long Island), Cold Spring Harbor (Long Island), Gowanda, Ithaca, Pelham; May 27–June 30. OHIO (2♂♂): Summit County; June 23–28. ONTARIO (2♂♂): Prescott, Walsh; July 1–6. PENNSYLVANIA (1♂): Benvenuto; June 4. SOUTH CAROLINA (1♂): Rocky Bottom (Pickens County); June 1. WISCONSIN (1♂): Madison; July 27.

REMARKS: Asa Fitch (1855) vividly described the activity of the adults of this species on apple, particularly its feeding activity on the "honey dew" exuded by the "apple plant lice."

All specimens of this species collected by me were found on black locust (*Robinia pseudo-acacia* L.). One female was observed ovi-

positing in a dried-up flower. The eggs are milky white in color and oblong (length about 1.4 mm., width 0.5 mm.) with round ends. Subsequent investigations disclosed no further ovipositing activity and no eggs. No larvae were discovered.

*Rivellia viridulans* Robineau Desvoidy

FIGURE 5,*d,e*

*Rivellia viridulans* Robineau Desvoidy, 1830, p. 729.—Loew, 1873, p. 88, pl. 8. fig. 4.—Hendel, 1914a, p. 181.—Cresson, 1924, p. 226.

TYPE LOCALITY: North America. (The type "détruits définitivement," according to E. Séguy, in litt.)

MALES: Body length 3.6–5.7 mm.; wing length 2.6–4.0 mm. Genitalia (fig. 5,*e*) with apical part of aedeagus consisting of a bulbous base and two long filamentous terminal tubes which are about one and a half times the length of basal part of aedeagus; cerci barely extend beyond proctiger. Otherwise similar to *R. melliginis*.

SPECIMENS EXAMINED: GEORGIA (1 ♂): Yonah Mountain; June 10. ILLINOIS (1 ♂): Algonquin; no date. IOWA (1 ♂): Polk City (4 miles northeast of Alleman); June. MASSACHUSETTS (1 ♂): Woods Hole; July 12. MISSISSIPPI (1 ♂): Oxford; May. MISSOURI (1 ♂): Parkville; June 25. NEW JERSEY (1 ♂): Ramsey; July 6. NEW YORK (64 ♂♂): Babylon (Long Island), Cold Spring Harbor (Long Island), Dix Hills (Long Island), East Queens, Farmingdale (Long Island), Flushing, Islip (Long Island); May 15–Aug. 15. NORTH CAROLINA (5 ♂♂): Fayetteville, Hendersonville, Raleigh, Valley of Black Mountains; June 12–July 17. OHIO (6 ♂♂): Summit County; June 19–28. VIRGINIA (2 ♂♂): Dixie Landing, Shenandoah National Park; May 25–June 20.

REMARKS: This species is very closely related to *R. melliginis*. The males of the two species can be separated by the difference in lengths of the terminal tubes of the aedeagus, and the extent by which the cerci extend beyond the proctiger. The terminal tubes in *R. viridulans* are about one and a half times and in *R. melliginis* about three times the length of the basal part of the aedeagus. In *R. viridulans* the cerci barely extend beyond the proctiger, whereas in *R. melliginis* they extend beyond the proctiger by about the length of the proctiger. I am unable to separate the females of these species.

In the past *R. melliginis* has been confused with this species. I have seen the type of *R. melliginis* and consider it a distinct species. Mr. E. Séguy has kindly informed me that the type of *R. viridulans* is "détruits définitivement." The original description of *R. viridulans* offers no information which will permit separation of these two species. Since, however, the species considered here is more common than

*R. melliginis*, it will be regarded as *R. viridulans*. Moreover, inasmuch as these two species cannot be separated, as far as I can determine, without examination of the male genitalia and since there is no indication of such examination, previous citations of *R. viridulans* other than the original may be referable to either *R. melliginis* or *R. viridulans*.

*Ortalis otroeda* Walker, *O. quadrifasciata* Walker, *O. bipars* Walker, and *Herina rufitarsis* Macquart have been considered synonyms of *R. viridulans* by previous workers. I have not seen the types of the aforementioned species and therefore cannot validate these synonyms.

***Rivellia inaequata*, new species**

FIGURE 3, *i-l*

HOLOTYPE: Male. Body length 5.0 mm.

Head: Frons yellowish brown; upper fronto-orbital plates concolorous with frons, ocellar triangle slightly blackened. Face with little less than dorsal half pruinose, remainder shining, smooth, pale brownish yellow; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments yellow; third segment with base yellow, remainder slightly blackened, the tip pointed anteriorly. Antelypeus concolorous with ventral portion of face. Palpi yellow. Posteranium brownish yellow, lightly pruinose.

Thorax: Mesonotum brownish yellow; strong humeral setae absent, posterior dorsocentral setae present. Scutellum and post-scutellum concolorous with mesonotum. Pleura concolorous with mesonotum, mostly shining, pruinosity obscure except on sternopleuron and laterotergite. Mesopleuron with scattered pale setae on posterior half. Sternopleuron with narrow pruinose strip on ventral margin, a narrower strip on posterior margin; disc with scattered pale setae. Pteropleuron with scattered pale setae on disc, few black setae present ventral to subalar. Laterotergite pruinose on ventral one-third. Prosternum yellow.

Thoracic appendages: Front legs: Coxae, femora, and tibiae yellow; tarsi blackened from tip of first segment, remainder of first segment yellow. Middle legs: Coxae brownish yellow; femora and tibiae yellow; tarsi blackened from third segment, remaining segments yellow. Hind legs: Coxae yellow; femora yellow; tibiae brownish yellow; tarsi blackened from second segment, remaining segments yellow.

Wing (fig. 3, *i*) length 3.2 mm., width 1.2 mm. Bands dark brown. First and second bands joined at costal margin; third and fourth bands joined at costal margin. The part of first basal cell contiguous

to second basal cell banded on about basal two-thirds, apical one-third hyaline, this hyaline area wedgelike basally. Section of fourth vein proximad of anterior crossvein with definite bend. Halteres yellowish brown.

Abdomen: Tergites shining, rugose. First, second, and third tergites brownish yellow, remaining tergites reddish black. Disc of first tergite with pale setae. Genitalia (fig. 3,*k,l*) with apical part of aedeagus with a bulbous base, which bears on the dorsum a stout horn on the left and a nodule on the right side. Attached terminally to this bulbous base is a dorsoventrally flattened oblong plate which bears at the apex two short diverging tubes.

ALLOTYPE: Female. Body length 5.0 mm.; wing length 3.5 mm., width 1.5 mm. Middle and hind coxae yellow. First two tergites of abdomen yellowish brown, except for posterior border of second tergite, remaining tergites reddish black; ovipositor sheath reddish black. Otherwise similar to holotype.

PARATYPES: 41 males, 33 females. Body length of males 4.3–5.4 mm., of females 4.0–6.0 mm.; wing length of males 3.0–3.5 mm., of females 3.2–4.0 mm. Sometimes abdominal tergites wholly brownish yellow. Otherwise essentially similar to holotype or allotype.

SPECIMENS: Holotype, ♂, Cedar Keys, Fla., Aug. 10, 1939, A. T. Hardy (SEC). Allotype, ♀, Labelle, Fla., July 16, 1939, A. T. Hardy (SEC). Paratypes: FLORIDA: (1 ♀, 1 ♂; 1 ♀ July 1882, Witfeld); Biscayne Bay (1 ♀); Bradenton (2 ♀ ♀, 2 ♂ ♂, March, M. C. Van Duzee); Cedar Keys (2 ♀ ♀, 2 ♂ ♂, July 12, 1939, D. E. Hardy; 1 ♀, 3 ♂ ♂, July 12, 1939, A. T. Hardy; 1 ♂, July 12, 1939, P. B. Lawson; 1 ♀, July 12, 1939, J. D. Beamer; 2 ♀ ♀, July 12, 1939, R. H. Beamer; 1 ♀, Aug. 10, 1939, A. T. Hardy; 1 ♂, Aug. 10, 1939, J. D. Beamer); Clearwater (1 ♀, Apr. 29, 1908, M. C. Van Duzee); De Land (1 ♀, 1 ♂, Aug. 8, 1939, D. E. Hardy); Elfers (2 ♂ ♂, July 14, 1939, D. E. Hardy); Labelle (2 ♀ ♀, July 16, 1939, D. E. Hardy); Miami (1 ♂, May 18, 1924, and 1 ♂, Aug. 2, 1924, S. Graenicher); New Smyrna Beach (1 ♀ June 6, 1942, D. G. Denning); Orange City (1 ♀, Apr. 22, 1928, C. O. Bare); Sanford (1 ♀, 1 ♂, April, 1926); South Miami (1 ♂, Aug. 29, 1949, Link-McPhail; 1 ♀, 5 ♂ ♂, Aug. 29, 1949, Link-Calkins); St. Petersburg (5 ♀ ♀, 2 ♂ ♂, Apr. 28, 1908, M. C. Van Duzee); West Palm Beach (1 ♂, June 11, 1941, L. W. Hepner); 25 miles west of Miami (2 ♂ ♂, July 22, 1934, R. H. Beamer). GEORGIA: (1 ♀; 3 ♀ ♀, CU Lot 35); Southern Georgia (2 ♀ ♀, 3 ♂ ♂, Morrison); Tybee Island (1 ♀, 2 ♂ ♂, July 26, 1913). LOUISIANA: Opelousas (1 ♀, April 1897). NEW JERSEY: Cape May (1 ♀, Sept. 8, 1932; 1 ♀, 1 ♂, July 24, 1936; 1 ♂, June 24, 1933; 1 ♂, Aug. 30, 1933; 3 ♂ ♂, July 13, 1933; 1 ♂, Aug. 24, 1932; 1 ♂, Aug. 12, 1935; 1 ♂, Aug.

16, 1938; 1 ♂, Aug. 9, 1933; 1 ♂, July 27, 1933; 2 ♂♂, Aug. 14, 1934; all collected by W. Stone). SOUTH CAROLINA: Manning (1 ♀, May 29, 1930, W. Stone). TEXAS: Victoria (1 ♀, June 1924, J. D. Mitchell). VIRGINIA: (1 ♂, Aug. 20, 1882). (In SEC, NC, CU, CAS, AMNH, USNM, CAN, UM, and ANSP.)

REMARKS: This species can be distinguished from the other *Rivellia* by the absence of the humeral setae, yellowish color of the head and thorax, and the male genitalia.

*Rivellia steyskali*, new species

FIGURE 4,*k-n*

HOLOTYPE: Male: Body length about 4.2 mm.

Head: Frons brown, upper fronto-orbital plates and ocellar triangle black. Face with dorsal half pruinose, ventral half shining, smooth, dark brown; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments yellow; third segment with tip and outside blackened, remainder yellow, the tip pointed anteriorly. Anteclypeus concolorous with ventral portion of face. Palpi dark brown. Posteranium black, pruinose.

Thorax: Mesonotum black; strong humeral setae absent, posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura black, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of right triangle, one side reaching ventral posterior corner, the other side almost attaining anterior spiracle. Sternopleuron with narrow pruinose strip on ventral margin and a much narrower pruinose strip on posterior margin; disc with scattered pale setae. Disc of pteropleuron with scattered pale setae, one black seta present ventral to subalar. Hypopleuron mostly shining, borders narrowly pruinose. Laterotergite completely and densely pruinose. Prosternum black.

Thoracic appendages: Front legs: Coxae, femora, and tibiae yellow; tarsi slightly blackened from third segment, remaining segments yellow. Middle legs: Coxae brown; femora and tibiae yellow; tarsi blackened from third segment, remaining segments yellow. Hind legs: Coxae brown; femora yellow; tibiae brownish yellow, tarsi yellow, blackened from third segment, remaining segments yellow.

Wing (fig. 4,*k*) length 3.3 mm., width 1.3 mm. Bands black. First and second bands definitely joined at costal margin; third and fourth bands joined at costal margin. The part of first basal cell contiguous to second basal cell banded on about basal two-thirds, apical one-third hyaline, this hyaline area wedgelike basally. Section

of fourth vein proximad of anterior crossvein with definite bend. Halteres yellowish brown.

Abdomen: Tergites shining, rugose, black. Disc of first tergite with pale setae. Genitalia (fig. 4,*m,n*) with apical part of aedeagus from dorsal view shaped like the sound box of a guitar; from lateral view, base bulbous, apex flattened.

ALLOTYPE: Female. Body length about 4.1 mm.; wing length 3.3 mm., width 1.4 mm. Middle and hind femora brownish toward base; hind tibiae dark brown. Ovipositor sheath black. Otherwise similar to holotype.

PARATYPES: 31 males, 71 females. Body length of males 3.3–4.9 mm., of females 3.6–5.3 mm.; wing length of males 2.5–3.5 mm., of females 2.8–3.7 mm. Both sexes with body color sometimes almost wholly black or brown. I have seen two males with dark brown thorax and yellowish brown abdominal tergites. Otherwise essentially similar to holotype or allotype.

SPECIMENS: Holotype, ♂, St. Joseph, Mich., July 2, 1942, C. W. Sabrosky (USNM 61858). Allotype, ♀, same data as holotype (USNM). Paratypes: ARKANSAS: Fayetteville (1♂, Aug. 15, 1907). ALABAMA: Garden City (1♀, 1♂, July 7, 1939, R. H. Beamer). GEORGIA: (1♂); Atlanta (1♀, June 27, 1933; 1♀, June 7, 1935; 1♀, June 8, 1935; 1♀, June 13, 1935; 1♀, May 20, 1937; 1♀, May 30, 1941; 1♀, July 15, 1942; 2♀♀, July 21, 1942; 1♀, July 28, 1942; 1♀, June 14, 1935, all collected by P. W. Fattig); Billy's Island, Okefenokee Swamp (1♂, June 1912; 1♂, June 15, 1912); Calhoun (1♀, Aug. 20, 1949); Ellaville (2♀♀, 1♂, May 18, 1937, P. W. Fattig); Griffin (3♀♀, 1♂, Aug. 12, 1939, R. H. Beamer; 1♂, Aug. 12, 1939, J. D. Beamer; 5♀♀, Aug. 12, 1939, A. T. Hardy; 1♀, Aug. 12, 1939, D. E. Hardy); Hiawassee (1♂, June 16, 1945, P. W. Fattig). IOWA: 1 mile south of Amana (1♂, June 23, 1928, G. Hendrickson); 10 miles southwest of Kelso (1♀, July 30, 1928, G. Hendrickson). KANSAS: Douglas County (1♀, June "900 ft."). KENTUCKY: Bardstown (1♀, May 29, 1942, D. G. Denning); Cumberland Gap (1♀, G. Dimmock). MARYLAND: Cabin John Br. (1♀, June 14, 1913, R. C. Shannon); Linnieville (1♀, July 7, 1913, R. C. Shannon); Plummers Island (1♀, R. P. Currie; 1♀, 1♂, June 29, 1913, R. C. Shannon). MICHIGAN: East Lansing (5♀♀, 4♂♂, July 15, 1948, R. Namba); Midland County (2♂♂, June 10, 1941, R. R. Dreisbach); Nottawa (1♀, May 30, 1941, R. R. Dreisbach); St. Joseph (1♀, July 2, 1942, C. W. Sabrosky). MINNESOTA: (1♂, Univ. of Minn., No. 13 sub 68); Carlos Avery Game Refuge, Anoka County (1♂, June 24, 1951, R. Namba); Ramsey County (1♀, June 29, 1951, R. Namba); University Farm, St. Paul, Minn. (3♀♀, 1♂,

June 29, 1951, R. Namba; 1 ♀, July 17, 1951, R. Namba). NEW JERSEY: Newark (1 ♀, June 18, 1892). NEW YORK: Babylon, Long Island (2 ♀ ♀, June 25, 1934, Blanton and Borders); Farmingdale, Long Island (2 ♀ ♀, 1 ♂, June 5, 1935, Blanton and Borders); Gowanda (1 ♀, June 13, 1913, M. C. Van Duzee); Mosholu (1 ♂, June 18); Station for Study of Insects, Tuxedo (1 ♂, July 10, 1928, C. H. Curran; 1 ♂, July 6, 1928, C. H. Curran). NORTH CAROLINA: (1 ♂); Black Mts. (1 ♀, "VI"); Valley of Black Mts. (2 ♀ ♀, June 24-30, 1906, W. Beutenmeller); Fayetteville (1 ♀, early June, 1921, C. S. Brimley); Goldsboro (1 ♀, July 20, 1946, M. W. Wing); Grimesland (1 ♀, May, 1919); Raleigh (1 ♂, June 11, 1924; 1 ♀, Aug. 13, 1925; 1 ♀, July 12, 1927; 1 ♂, Sept. 4, 1925; 1 ♂, July 28, 1926, all collected by C. S. Brimley; 1 ♀, June 21, 1947, G. S. Fichter; 1 ♀, July 5, 1948, "at light," M. W. Wing; 1 ♀, early August, C. L. Metcalf); Smokemont, GSMNP (1 ♂, Aug. 15, 1947, Bullock-R. R. Dreisbach). OHIO: Summit County (1 ♂, July 13, 1936; 1 ♀, June 16, 1937; 2 ♀ ♀, June 19, 1937; 1 ♂, June 28, 1937, all collected by Louis J. Lipovsky). PENNSYLVANIA: Fern Rock (1 ♂, June 9, 1905; 1 ♀, June 29, 1905); Manayunk (1 ♀, 1 ♂); Montgomery County (1 ♀, July 4, 1892). TENNESSEE: Elkmont, GSMNP (3 ♀ ♀, June 15, 1946, R. R. Dreisbach; 1 ♀, Aug. 11, 1947, Bullock-R. R. Dreisbach); Headquarters, GSMNP (1 ♀, Aug. 15, 1947, 1,600 ft., Bullock-R. R. Dreisbach); The Chimneys, GSMNP (1 ♀, June 11, 1946). TEXAS: Kerrville (1 ♀, May 30, 1906, F. C. Pratt). VIRGINIA: Great Falls (1 ♀, June 12, 1949, C. W. Sabrosky); Mount Airy (1 ♂, July 17, 1941, Olson). DISTRICT OF COLUMBIA (1 ♀, F. C. Pratt). (In CSW, UM, USNM, SEC, EU, CU, AMNH, NC, ISC, RRD, GS, and ANSP.)

REMARKS: This species can be separated from the other *Rivellia* by the absence of the strong humeral setae and presence of posterior dorsocentral setae, and by the yellow front legs, male genitalia, wings, and the usual unicolorous black or dark brown body color.

This species is named in honor of Mr. George C. Steyskal, who has aided me in the study of Diptera.

***Rivellia boscii* Robineau Desvoidy**

FIGURE 2, a-c

*Rivellia boscii* Robineau Desvoidy, 1830, p. 730.—Piersol, 1907, pp. 465-467 (on mating habit).

TYPE LOCALITY: "La Caroline." (The type "détruits définitivement," according to E. Séguy, in litt.)

MALE: Body length about 7.0 mm.; with neat slender appearance.

Head: Frons reddish brown; upper fronto-orbital plates and ocellar triangle slightly blackened. Face with dorsal one-third pruinose,



remainder shining, slightly rugulose, brown; parafacials and part of orbits ventral to each eye yellow. Antenna somewhat cylindrical in general appearance, little tapered toward rounded tip; first and second segments yellow; third segment with tip and outside slightly blackened, remainder yellow. Anteclypeus concolorous with ventral portion of face. Palpi yellow. Postcranium strongly convex; shining black, not pruinose. Head directed anteriorly instead of ventrally as is the case in other *Rivellia*.

Thorax: Mesonotum black; strong humeral and posterior dorso-central setae absent, relatively strong anterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum; lateral pair of scutellar setae very weak, about one-fifth the length of apical pair; shining area on postscutellum confined to medioposterior spot. Pleura dark brown. Mesopleuron with scattered pale setae on posterior two-thirds; posterior two-thirds pruinose. Sternopleuron almost wholly pruinose, only anterior and posterior corners shining; disc with scattered pale setae. Disc of pteropleuron with scattered pale setae, few black setae present ventral to subalar. Hypopleuron with shining central spot, remainder pruinose. Laterotergite completely and densely pruinose. Prosternum black.

Thoracic appendages: All legs with coxae and femora yellow. Front and middle tibiae yellow; hind tibiae brownish yellow. Fore tarsi and middle tarsi slightly blackened from second segment, remaining segments yellow; hind tarsi blackened from fourth segment, remaining segments yellow.

Wing (fig. 2,a) length 4.3 mm., width 1.6 mm. Bands dark brown, narrow. First and second bands definitely joined at costal margin; third and fourth bands joined at costal margin. The part of first basal cell contiguous to second basal cell banded at base anteriorly; the hyaline area contiguous to fourth vein sharply wedgelike to base of second basal cell. Section of fourth vein proximad of anterior crossvein with very slight bend. Halteres yellowish brown.

Abdomen: Tergites black, definitely pruinose except for shining medial transverse band on first-second syntergite, this band broadened laterally. Disc of first tergite with pale setae. Genitalia (fig. 2,c) with apical part of the aedeagus consisting of two stout apically directed hooks which are joined at base.

FEMALES: Body length 6.2–7.5 mm.; wing length 4.0–4.6 mm. Prosternum yellow; abdomen with yellow lateral spot on each side at base on dorsum; ovipositor sheath black. Otherwise similar to male.

SPECIMENS EXAMINED: FLORIDA: Jacksonville (1 ♀, collection of Mrs. A. T. Slosson); Suwanee Springs (1 ♀, 1 ♂, July 29, 1939, R. H. Beamer). GEORGIA: Perry (1 ♀, Aug. 12, 1939, R. H. Beamer). NORTH CAROLINA: Fayetteville (1 ♀, early June, 1921, C. S. Brimley).

REMARKS: According to Mr. E. Séguy, the type of this species is "détruits définitivement."

This species stands apart from the rest of the *Rivellia* species. The neat, slender appearance of body, anteriorly protruding head, absence of both strong humeral and posterior dorsocentral setae, and the presence of a pair of strong anterior dorsocentral setae, weak lateral scutellar setae, and the definitely pruinose abdominal tergites make this species unique among the *Rivellia*.

*Rivellia socialis*, new species

FIGURE 10,*m*

HOLOTYPE: Male. Body length about 5.2 mm.

Head: Frons reddish brown; ocellar triangle blackened, upper fronto-orbital plates concolorous with frons. Face with dorsal half pruinose, ventral half shining, smooth, dark brown; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments brownish yellow; third segment brown, yellow only on inside at base, the tip pointed anteriorly. Anteclypeus black. Palpi brown. Postcranium black, pruinose; more convex than other *Rivellia* except *R. boscii*.

Thorax: Mesonotum black; strong humeral and posterior dorsocentral setae absent. Scutellum and postscutellum concolorous with mesonotum. Pleura black, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinosity reduced to small spot at dorsal posterior corner. Sternopleuron with narrow pruinose strip on ventral margin and a much narrower strip on posterior margin; disc with scattered pale setae. Disc of pteropleuron with scattered pale setae, few black setae present ventral to subalar. Hypopleuron with shining central spot, remainder pruinose. Laterotergite completely and densely pruinose. Prosternum black.

Thoracic appendages: Coxae, femora, and tibiae of all legs black; all tarsi gradually blackened toward tip after first segment, first segment yellow.

Wing (fig. 10,*m*) length 3.5 mm., width 1.3 mm. Bands black. First and second bands definitely joined at costal margin; third and fourth bands joined at costal margin. The part of first basal cell contiguous to second basal cell banded on about basal two-thirds, apical one-third hyaline, this hyaline area wedgelike basally. Section of fourth vein proximad of anterior crossvein with definite bend. Halteres brown.

Abdomen: Tergites black, appear pruinose, except for shining medial transverse band on first-second syntergite, this band broadened laterally. Disc of first tergite with pale setae. Genitalia similar to that of *R. steyskali*.

ALLOTYPE: Female. Body length about 5.0 mm.; wing length 3.2 mm., width 1.2 mm. Thorax dark brown; ovipositor sheath dark brown. Otherwise similar to holotype.

PARATYPES: 7 males, 3 females. Body length of males 5.0–5.2 mm., of females 4.7–5.4 mm.; wing length of males 3.4–3.6 mm., of females 3.3–3.6 mm. I have seen one female with one posterior dorsocentral seta on the right side. Otherwise similar to holotype or allotype.

SPECIMENS: Holotype, ♂, Buffalo Center, Iowa, July 7, 1928, G. O. Hendrickson (ISC). Allotype, ♀, Ames, Iowa, June 18, 1926, G. O. Hendrickson (ISC). Paratypes: ILLINOIS: (2 ♀ ♀, 1 ♂); Champaign (1 ♀, 3 ♂ ♂, May 27, 1889, Marten, "15005"). IOWA: Ames "e" (1 ♂, July 10, 1925, and 1 ♂, May 31, 1926, G. O. Hendrickson); 7 miles northwest of Thompson (1 ♂, June 30, 1928, G. O. Hendrickson). (In ISC, SEC, and INHS.)

REMARKS: The pronounced convexity of the postcranium, the absence of both strong humeral and posterior dorsocentral setae, and the pruinose abdominal tergites indicate affinity of this species to *R. boscii*. It can be distinguished from *R. boscii* by the ventrally directed head, the presence of strong lateral scutellar setae, the lesser amount of pruinosity on the sternopleuron and mesopleuron, the male genitalia, and the presence of a complete shining median band on the postscutellum.

*Rivellia succinata* (Wiedemann)

FIGURE 1, a–c

*Dacus succinatus* Wiedemann, 1830, p. 526.

*Rivellia succinata* (Wiedemann). Hendel, 1914a, p. 173, pl. 1, fig. 19; 1914b, pl. 1, fig. 18.

TYPE LOCALITY: "Väterland?" (Wiedemann, 1830). Types deposited "Im Wiener Musseum und in meiner Sammlung" (Wiedemann, 1830).

MALES: Body length about 4.5 mm.

Head: Frons yellow; upper fronto-orbital plates and ocellar triangle yellow; inner vertical setae absent. Face with dorsal half pruinose, ventral half shining, smooth, yellow; parafacials and part of orbits ventral to each eye brownish yellow. Antenna completely yellow, tip of third segment pointed anteriorly. Anteclypeus yellow. Palpi yellow. Postcranium yellow, lightly pruinose.

Thorax: Mesonotum yellow; strong humeral setae absent, posterior dorsocentral setae present. Scutellum yellow, somewhat brownish at apex. Postscutellum concolorous with mesonotum. Pleura yellow, mostly shining, pruinosity obscure except on laterotergite. Meso-

pleuron with scattered pale and black setae on posterior half; sternopleuron with scattered pale and black setae on disc; pteropleuron with scattered pale setae, few black setae present ventral to subalar. Laterotergite completely pruinose. Prosternum yellow.

Thoracic appendages: Front and middle legs: Coxae, femora, and tibiae completely yellow; tarsi very slightly blackened from third segment, remaining segments yellow. Hind legs: Coxae and femora yellow; tibiae light brownish yellow; tarsi blackened from third segment, remaining segments yellow.

Wing (fig. 1,a) length 3.7 and 4.0 mm., width 1.7 mm. Bands light brown, broad. First band covers most of the base of the wing although faintly in the axillary lobe and anal and axillary cells. Second band joined faintly to first band at costal margin, joined distinctly to third band in discal cell. Third and fourth bands broadly joined at costal margin. Section of fourth vein proximad of anterior crossvein with deep bend. Halteres yellow, capitulum somewhat brownish.

Abdomen: Tergites shining yellow, slightly rugose, with scattered brownish blotches. Disc of first tergite with pale setae. Genitalia (fig. 1,c) with apical part of aedeagus consisting of a slender neck, bulbous head, and two long terminal tubes each bearing a horn at basal one-third.

FEMALE: Body length 5.0 mm.; wing length 4.2 mm., width 2.0 mm.; ovipositor sheath brownish yellow, blackened laterally at tip. Otherwise similar to holotype.

SPECIMENS EXAMINED: FLORIDA: Hilliard (2♂♂, Aug. 19, 1930, and 1♀, Aug. 31, 1930, R. H. Beamer).

This species can be easily distinguished from the other *Rivellia* by the wing banding, the absence of inner verticals and strong humeral setae, the general yellowish color, and the male genitalia.

### *Rivellia quadrifasciata* (Macquart)

FIGURE 6,a-c

*Herina quadrifasciata* Macquart, 1835, p. 433.

*Rivellia quadrifasciata* (Macquart). Loew, 1873, p. 90, pl. 8, fig. 5.—Hendel, 1914a, p. 180.—Cresson, 1924, p. 227.

TYPE LOCALITY: North America. (The type "très certainement détruits," according to E. Séguy, in litt.)

MALES: Body length 3.6–6.4 mm.; wing length 3.0–4.0 mm. Genitalia (fig. 6,b,c) with apical part of aedeagus from lateral view consisting of a somewhat hemispherical base and two filamentous terminal tubes which are subequal in length to basal part of aedeagus. Fourth sternite of abdomen with radially directed setae. Otherwise similar to *R. colei*.

SPECIMENS EXAMINED: ALABAMA (21 ♂♂): Atmore, Decatur; July 6–11. COLORADO (2 ♂♂): Wray; Aug. 23. FLORIDA (64 ♂♂): Bratt, Hibernia; July 10–Aug. 29. GEORGIA (7 ♂♂): Atlanta, Billy's Island (Okefenokee Swamp), Dewitt, Ellaville, Griffin, Roberta, Statham; May 19–Sept. 8. ILLINOIS (2 ♂♂): Dubois, Meredosia; May 24–29. INDIANA (2 ♂♂): LaFayette, Logansport; June 21–Aug. 10. IOWA (2 ♂♂): Pleasant Valley, Sioux City; June 10–July 5. KANSAS (3 ♂♂): Douglas County, Montgomery County, Wichita; June 21–Aug. 26. MARYLAND (3 ♂♂): Chesapeake Beach; May 24–Aug. 19. MONTANA (1 ♂): No date. NEBRASKA (1 ♂): Valentine; June 8. NORTH CAROLINA (3 ♂♂): Beaufort, Lake Waccamaw, Raleigh; April 14–June 7. NORTH DAKOTA (2 ♂♂): Bismarck; June 14. NEW JERSEY (8 ♂♂): Atlantic City, Cape May, Clementon, Lakehurst, Stone Harbor, Wildwood; July 5–Sept. 2. NEW YORK (2 ♂♂): Mosholu, Peru; June 24. OKLAHOMA (1 ♂): Norman; May 4. QUEBEC (1 ♂) Abbotsford; April 14. SOUTH CAROLINA (12 ♂♂): Clemson College, Fairfax, Manning; May 29–Aug. 23. SOUTH DAKOTA (1 ♂): Elk Point; no date. TEXAS (1 ♂): Galveston; May. VIRGINIA (2 ♂♂): Smithfield; no date.

REMARKS: Mr. E. Séguy of the Muséum National d'Histoire Naturelle, Paris, has informed me (in litt.) that the types of *Herina quadrifasciata* Macquart and another species "ont disparu et sont très certainement détruits." In view of this statement and the inadequacy of the original description of *Herina quadrifasciata*, I have no way to ascertain whether *R. colei* or the species now under consideration is *R. quadrifasciata* (Macquart). However, since the species here described is more common (especially in the eastern United States) and more widespread than *R. colei*, I am regarding it as *R. quadrifasciata*.

Inasmuch as these two species cannot be separated, as far as I can determine, without examination of the male genitalia and since there is no indication of such examination, previous citations of *R. quadrifasciata* other than the original may be referable to either *R. quadrifasciata* or *R. colei*.

#### *Rivellia colei*, new species

FIGURE 6, d–f

Not *Rivellia viridulans* Robineau Desvoidy.—Cole, 1927, p. 443, fig. 252.

HOLOTYPE: Male. Body length about 4.7 mm.

Head: Frons reddish brown; upper fronto-orbital plates and ocellar triangle blackened. Face with dorsal half pruinose, ventral half shining, pale brownish yellow; parafacials and part of orbits ventral to each eye brownish yellow. Antenna with first and second segments

yellow; third segment blackened at tip and on outside, remainder yellow, the tip pointed anteriorly. Anteclypeus pale brownish yellow. Palpi yellow. Postcranium black, pruinose.

Thorax: Mesonotum black; strong humeral setae absent, posterior dorsocentral setae present. Scutellum and postscutellum concolorous with mesonotum. Pleura black, mostly shining. Mesopleuron with scattered pale setae on posterior half; pruinose area at dorsal posterior corner in form of right triangle, one side reaching ventral posterior corner, the other, the anterior spiracle. Sternopleuron with ventral margin broadly pruinose and with irregular band which extends from ventral corner to dorsal margin of sternopleuron; disc with scattered pale setae. Disc of pteropleuron with scattered pale setae, no black setae evident ventral to subalar. Hypopleuron with shining central spot, remainder pruinose. Laterotergite densely pruinose. Prosternum brown medially, with yellow borders.

Thoracic appendages: All legs with coxae and femora wholly yellow. Front and middle tibiae yellow, hind tibiae black. Front and hind tarsi slightly blackened from second segment, first segment yellow. Middle tarsi wholly yellow.

Wing (fig. 6,d) length 3.5 mm., width 1.5 mm. Bands black. First and second bands joined at costal margin; third and fourth bands joined at costal margin. The part of first basal cell contiguous to second basal cell banded on about basal two-thirds; apical one-third hyaline, this hyaline area wedge-like basally. Section of fourth vein proximad of anterior crossvein with definite bend. Halteres yellow.

Abdomen: Tergites shining, rugose, brownish yellow. Disc of first tergite with pale setae. Genitalia (fig. 6,f) with apical part of aedeagus consisting of a long cylindrical neck, a small spherical head, and two long terminal tubes which are about twice as long as the neck.

ALLOTYPE: Female (collected with holotype). Body length about 4.4 mm., wing length 3.3 mm., width 1.4 mm. Middle tarsi blackened from third segment. Ovipositor sheath black. Otherwise similar to holotype.

PARATYPES: 34 males. Body length 4.0–4.9 mm.; wing length 3.1–3.5 mm. Frons sometimes yellowish brown; postcranium sometimes blackish green. Thorax sometimes dark brown or blackish green; medial pruinose band on sternopleuron frequently absent. Hind tibiae brownish yellow to dark brown. Prosternum sometimes wholly yellow. One male with abdominal tergites almost wholly dark brown; this may be owing to contents of abdomen. Otherwise similar to holotype.

SPECIMENS: Holotype, ♂, Mississippi Bluff, one-half mile north of state line, Houston County, Minn., June 1, 1951, R. Namba (UM).

Allotype, ♀, same data as holotype. Paratypes: CONNECTICUT: Avon Old Farms, Avon (1♂, June 20, 1929, C. H. Curran). ILLINOIS: Champaign (1♂, May 15, 1889, "481"); Meredosia (1♂, May 29, 1917; 1♂, Aug. 20, 1917, "sand pit"); Normal (1♂, July 1-10, 1883, "3478"; 1♂, August 1883, "3531"); Savanna (1♂, July 26, 1892, McElfresh, "18530"); Urbana (1♂, Sept. 1, 1889, "580"). IOWA: 10 miles southwest of Kelso (2♂♂, July 30, 1928, G. O. Hendrickson); Sioux City (1♂, June 3, 1931, C. N. Ainslie). LOUISIANA: Opelousas (1♂, April 1897). MISSOURI: Shrewsbury (?) (1♂, July 10, 1949, and 5♂♂, Aug. 6, 1949, W. Downes). NEBRASKA: Fullerton (1♂, Aug. 19, 1949, R. K. Schwab-R. R. Dreisbach). NEW JERSEY: Cape May (1♂, June 24, 1933, Witmer Stone); Stone Harbor (1♂, Aug. 6, 1935, E. T. Cresson Jr.); Van Cortland (1♂, July 11, 1895, J. L. Zabriskie); Whitehorse (2♂♂, June 20, 1933, F. S. Blanton). NEW YORK: N. Tarrytown (4♂♂, Aug. 10, 1935, Blanton and Borders); Yonkers (1♂). NORTH CAROLINA: Hendersonville (2♂♂, June, 1907, F. Sherman). PENNSYLVANIA: Glenside (1♂, July 5, 1909, G. M. Greene). TENNESSEE: Knoxville (1♂, July 2, 1891, H. E. Summers). VIRGINIA: Boykins (1♂, June 10, 1895). (In INHS, NC, CU, CAS, SEC, and USNM.)

REMARKS: This species is very closely related to *R. quadrifasciata*. The males of these species can be easily differentiated by the genitalia. However, no diagnostic character could be found to separate the females. From other *Rivellia*, *R. colei* can be distinguished by the male genitalia, blackish thorax and yellowish abdominal tergites, and the wing banding.

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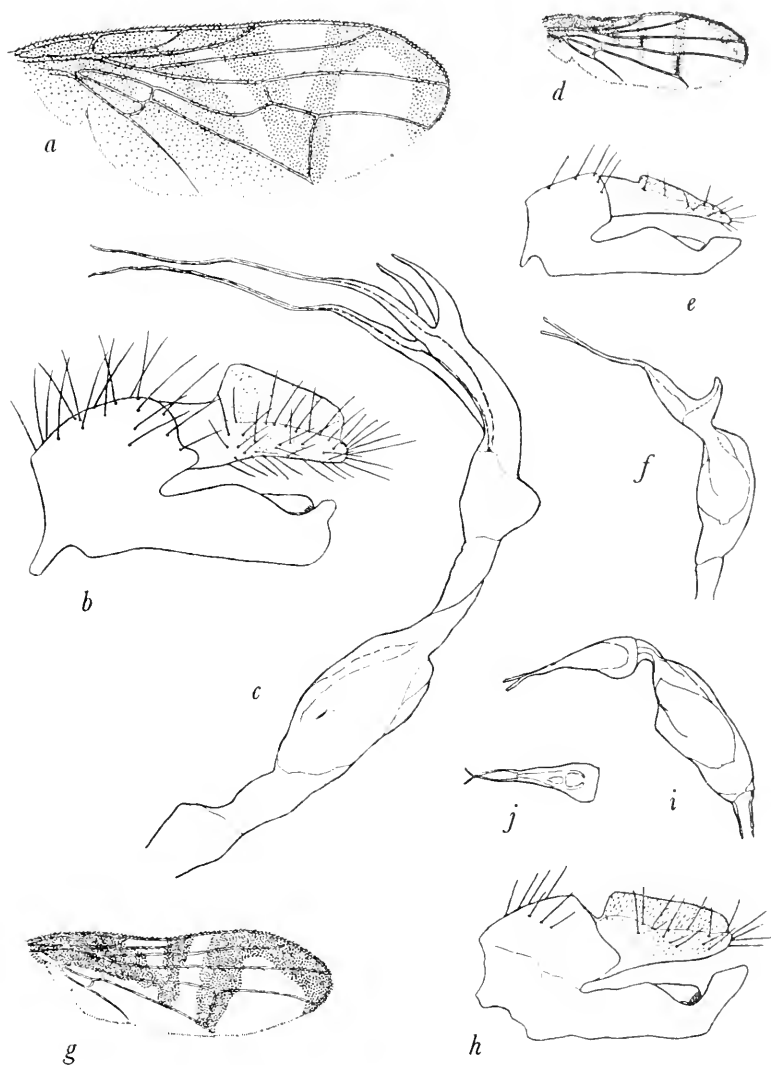


FIGURE 1.—*a-c*, *Rivellia succinata* Wiedemann: *a*, wing; *b*, lateral aspect of ninth tergite and proctiger of male; *c*, lateral aspect of aedeagus. *d-f*, *R. vaga*, new species: *d*, wing, *e*, lateral aspect of ninth tergite and proctiger of male; *f*, lateral aspect of aedeagus. *g-j*, *R. coquilletti* Hendel: *g*, wing; *h*, lateral aspect of ninth tergite and proctiger of male; *i*, lateral aspect of aedeagus; *j*, dorsal aspect of aedeagus.

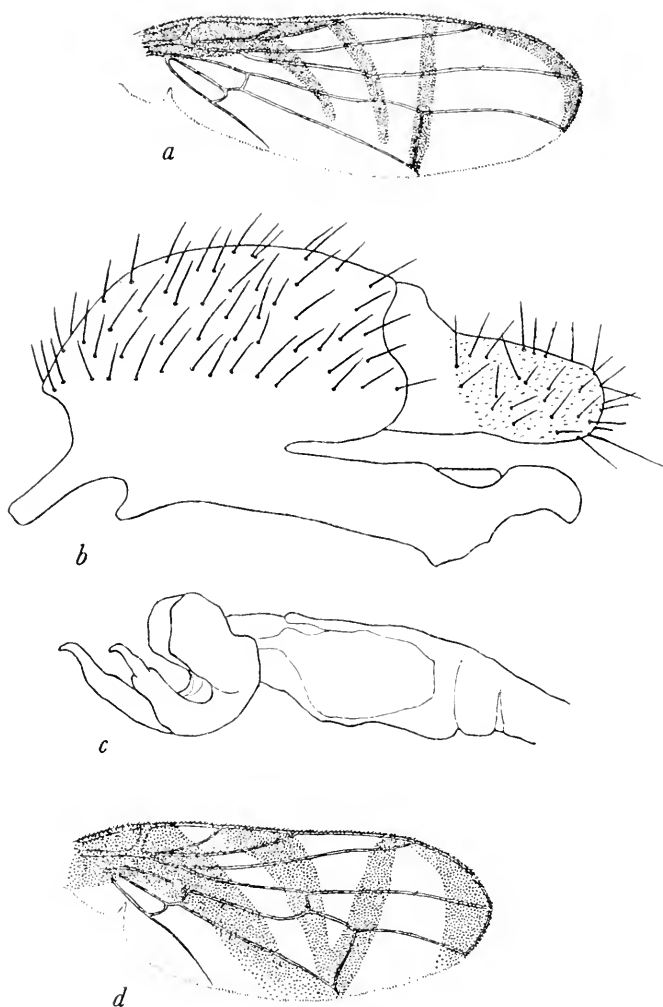


FIGURE 2.—*a-c*, *Rivellia boscii* Robineau Desvoidy: *a*, wing; *b*, lateral aspect of ninth tergite and proctiger of male; *c*, lateral aspect of aedeagus. *d*, *R. floridana* Johnson: wing.

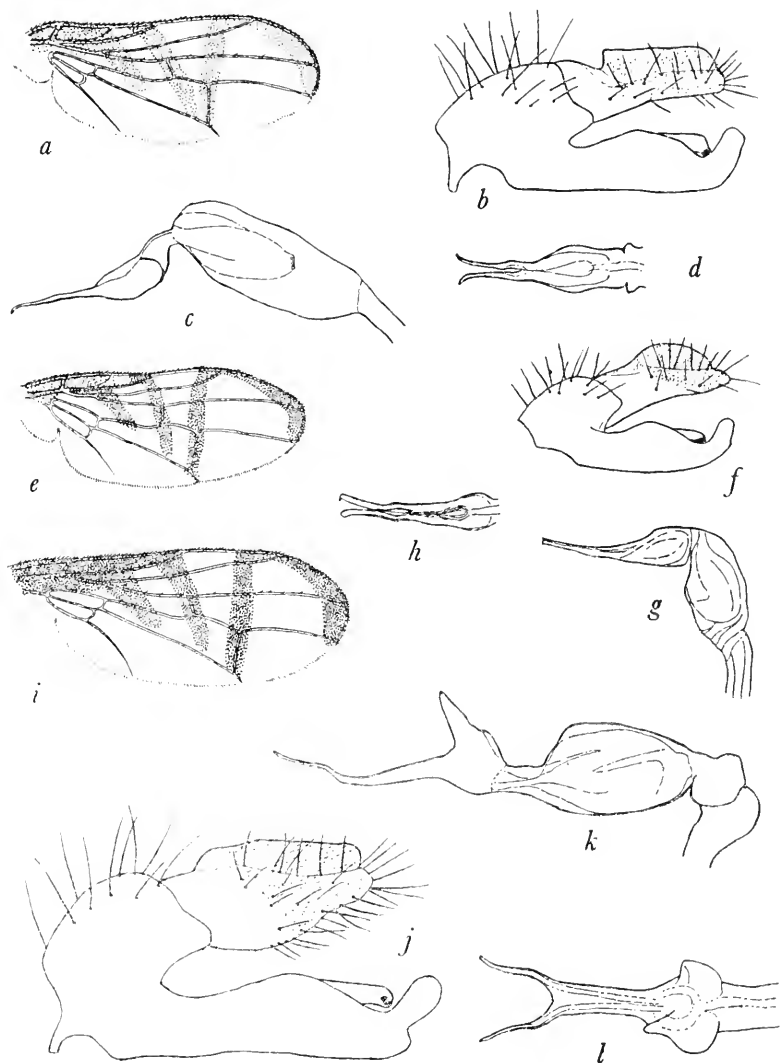


FIGURE 3.—*a-d*, *Rivellia imitabilis*, new species: *a*, wing; *b*, lateral aspect of ninth tergite and proctiger of male; *c*, lateral aspect of aedeagus; *d*, dorsal aspect of aedeagus. *e-h*, *R. pallida* Loew: *e*, wing; *f*, lateral aspect of ninth tergite and proctiger of male; *g*, lateral aspect of aedeagus; *h*, dorsal aspect of aedeagus. *i-l*, *R. inaequata*, new species: *i*, wing; *j*, lateral aspect of ninth tergite and proctiger of male; *k*, lateral aspect of aedeagus; *l*, dorsal aspect of aedeagus.

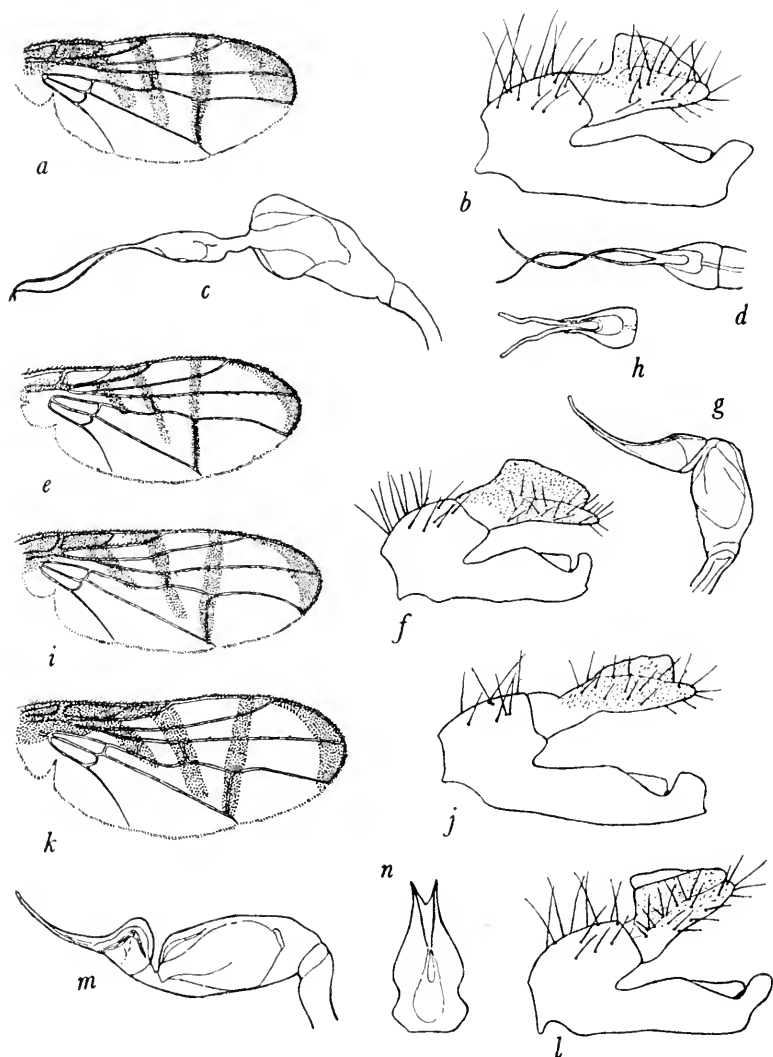


FIGURE 4.—a-d, *Rivellia michiganensis*, new species: a, wing; b, lateral aspect of ninth tergite and proctiger of male; c, lateral aspect of aedeagus; d, dorsal aspect of aedeagus. e-h, *R. metallica* Van Der Wulp: e, wing; f, lateral aspect of ninth tergite and proctiger of male; g, lateral aspect of aedeagus; h, dorsal aspect of aedeagus. i, j, *R. flavimana* Loew: i, wing; j, lateral aspect of ninth tergite and proctiger of male. k-n, *R. steyskali*, new species: k, wing; l, lateral aspect of ninth tergite and proctiger of male; m, lateral aspect of aedeagus; n, dorsal aspect of aedeagus.

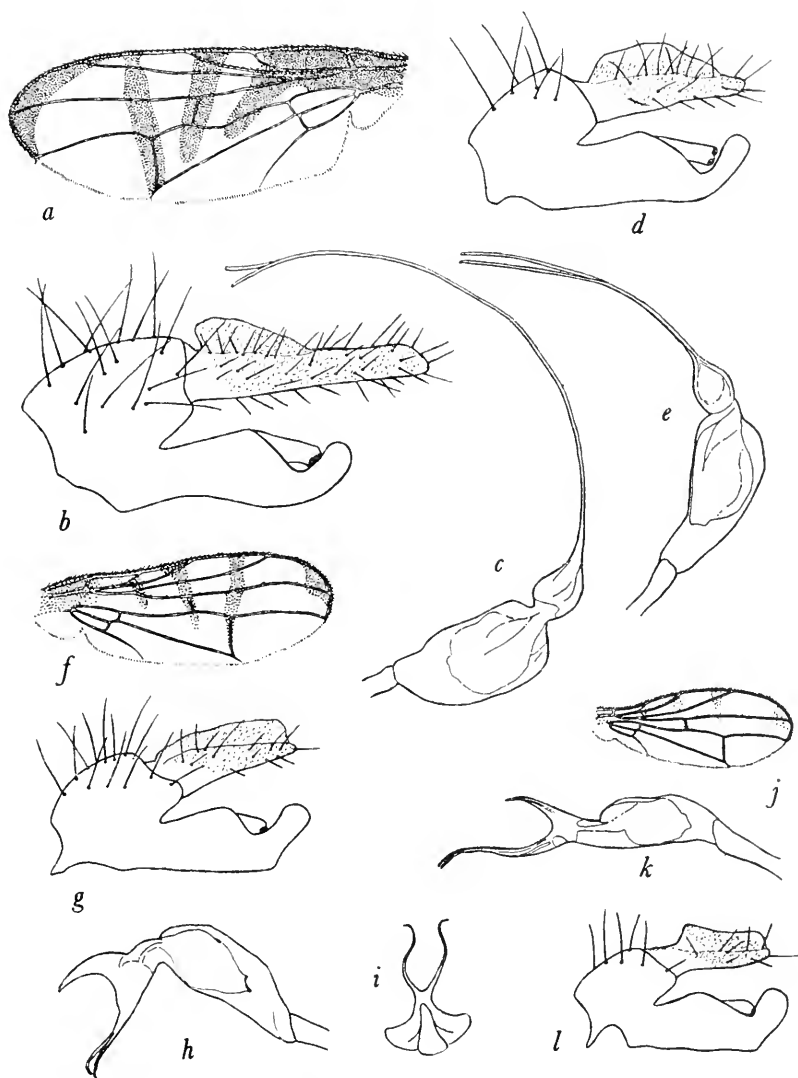


FIGURE 5.—*a-c*, *Rivellia melliginis* (Fitch): *a*, wing; *b*, lateral aspect of ninth tergite and proctiger of male; *c*, lateral aspect of aedeagus. *d, e*, *R. viridulans* Robineau Desvoidy: *d*, lateral aspect of ninth tergite and proctiger of male; *e*, lateral aspect of aedeagus. *f-i*, *R. texana*, new species: *f*, wing; *g*, lateral aspect of ninth tergite and proctiger of male; *h*, lateral aspect of aedeagus; *i*, dorsal aspect of aedeagus. *j-l*, *R. maculosa*, new species: *j*, wing; *k*, lateral aspect of aedeagus; *l*, lateral aspect of ninth tergite and proctiger of male.

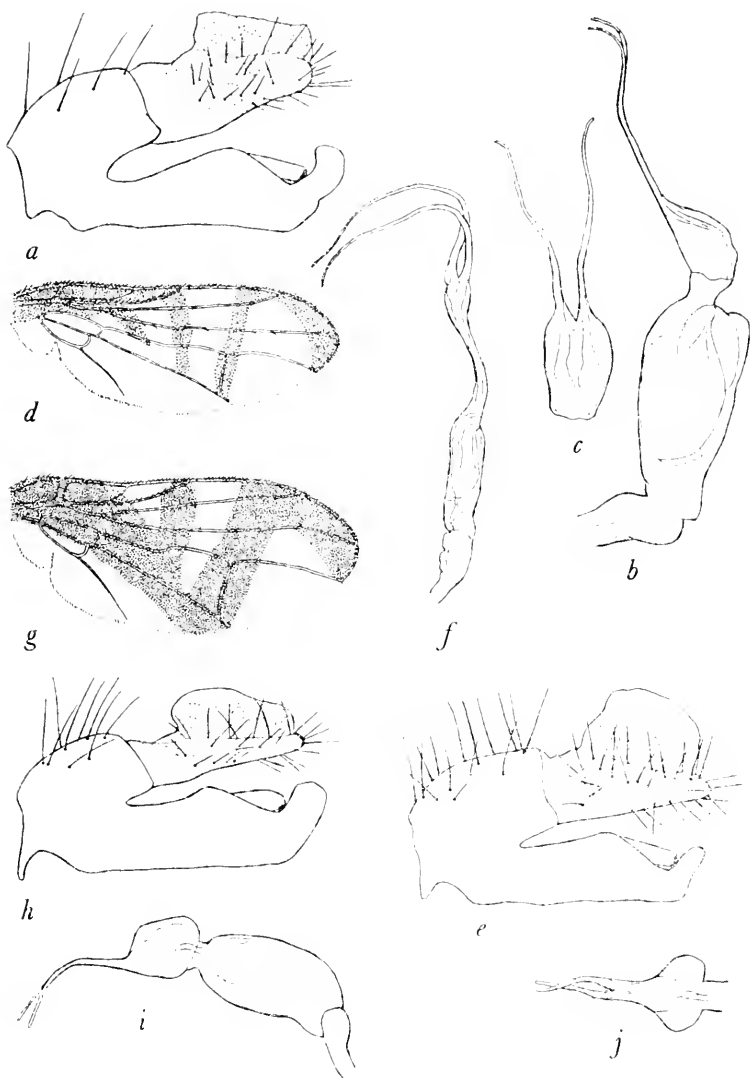


FIGURE 6.—*a-c*, *Rivellia quadrifasciata* Macquart: *a*, lateral aspect of ninth tergite and proctiger of male; *b*, lateral aspect of aedeagus; *c*, dorsal aspect of aedeagus. *d-f*, *R. colei*, new species: *d*, wing; *e*, lateral aspect of ninth tergite and proctiger of male; *f*, lateral aspect of aedeagus. *g-j*, *R. conjuncta* Loew: *g*, wing; *h*, lateral aspect of ninth tergite and proctiger of male; *i*, lateral aspect of aedeagus; *j*, dorsal aspect of aedeagus.

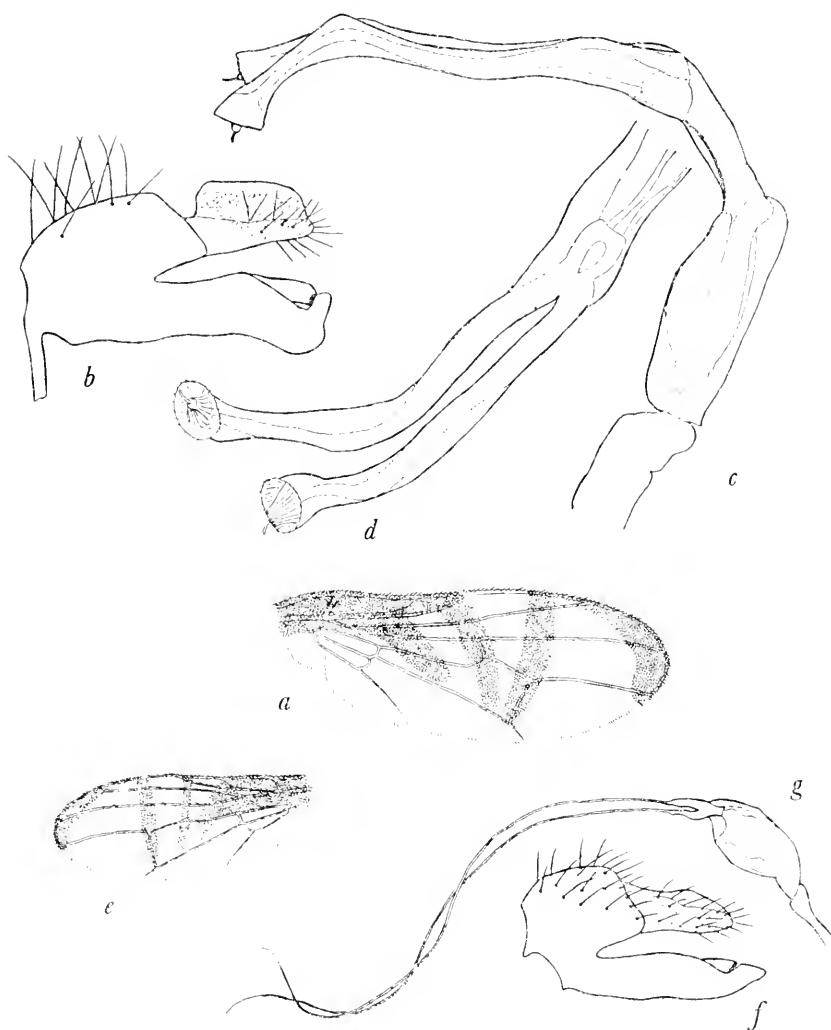


FIGURE 7.—a-d, *Rivellia munda*, new species: a, wing; b, lateral aspect of ninth tergite and proctiger of male; c, lateral aspect of aedeagus; d, dorsal aspect of aedeagus. e-g, *R. australis*, new species: e, wing; f, lateral aspect of ninth tergite and proctiger of male; g, lateral aspect of aedeagus.

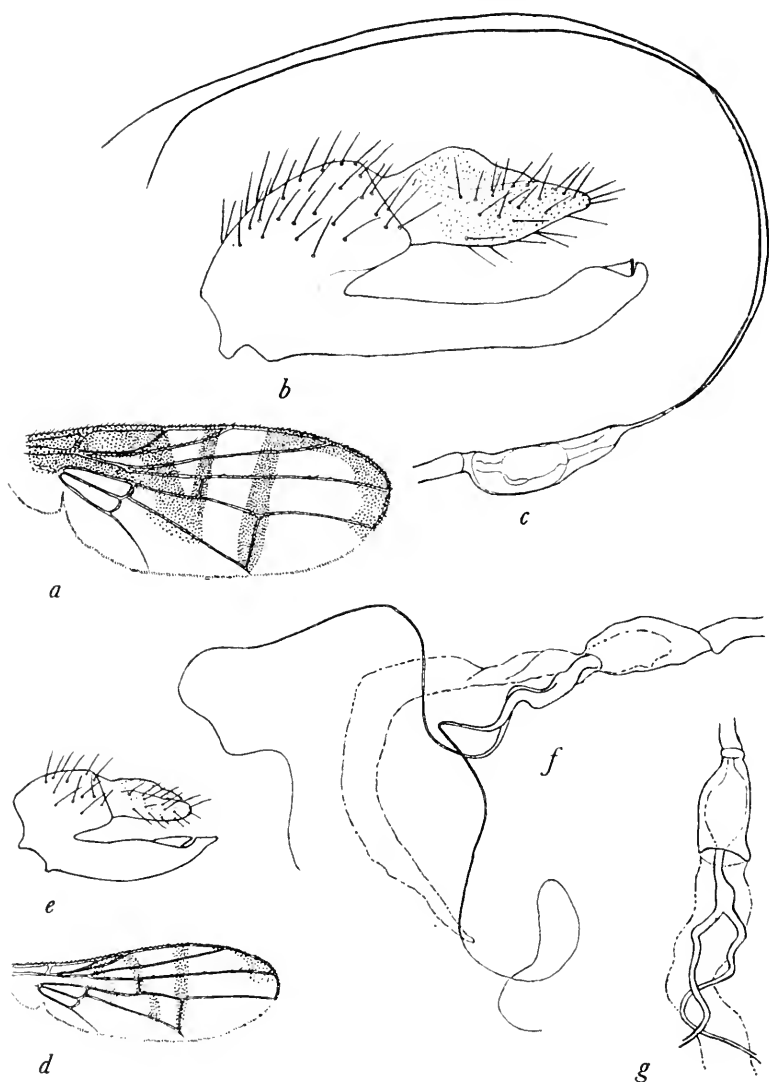


FIGURE 8.—a-c, *Rivellia tersa*, new species: a, wing; b, lateral aspect of ninth tergite and proctiger of male; c, lateral aspect of aedeagus. d-g, *R. occulta* Van Der Wulp: d, wing; e, lateral aspect of ninth tergite and proctiger of male; f, lateral aspect of aedeagus; g, dorsal aspect of aedeagus.



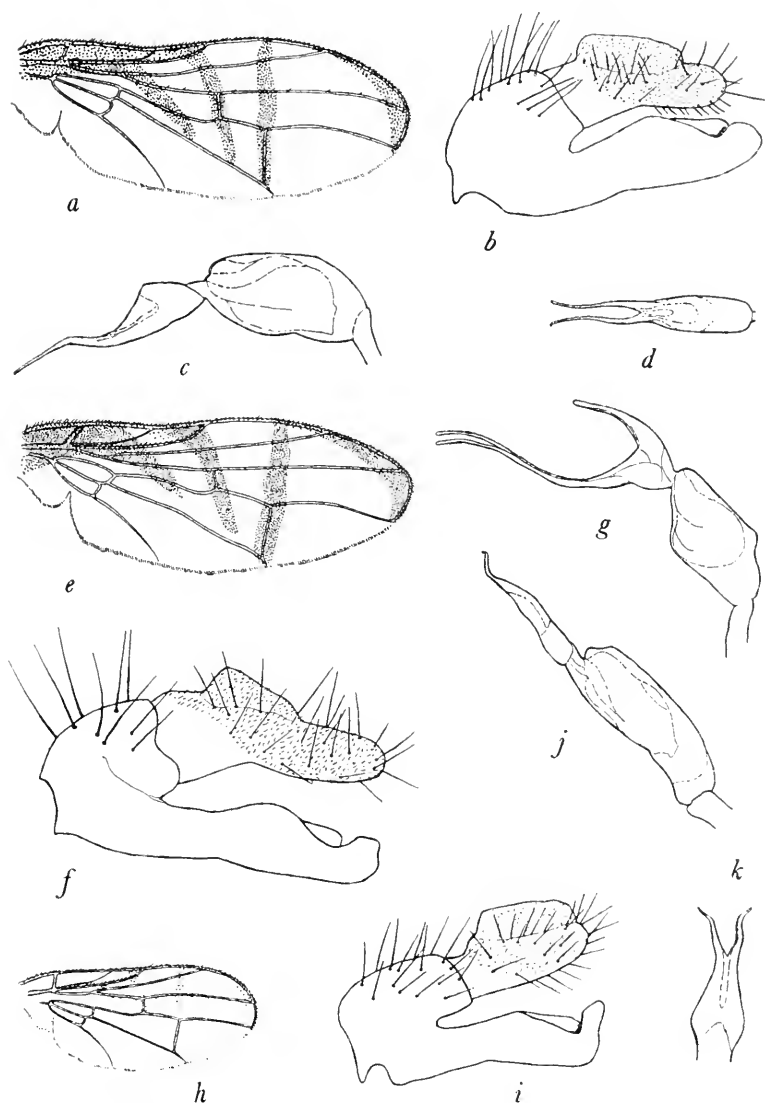


FIGURE 9.—*a-d*, *Rivellia variabilis* Loew: *a*, wing; *b*, lateral aspect of ninth tergite and proctiger of male; *c*, lateral aspect of aedeagus; *d*, dorsal aspect of aedeagus. *e-g*, *R. winifredae*, new species: *e*, wing; *f*, lateral aspect of ninth tergite and proctiger of male; *g*, lateral aspect of aedeagus. *h-k*, *R. brevifasciata* Johnson: *h*, wing; *i*, lateral aspect of ninth tergite and proctiger of male; *j*, lateral aspect of aedeagus; *k*, dorsal aspect of aedeagus.

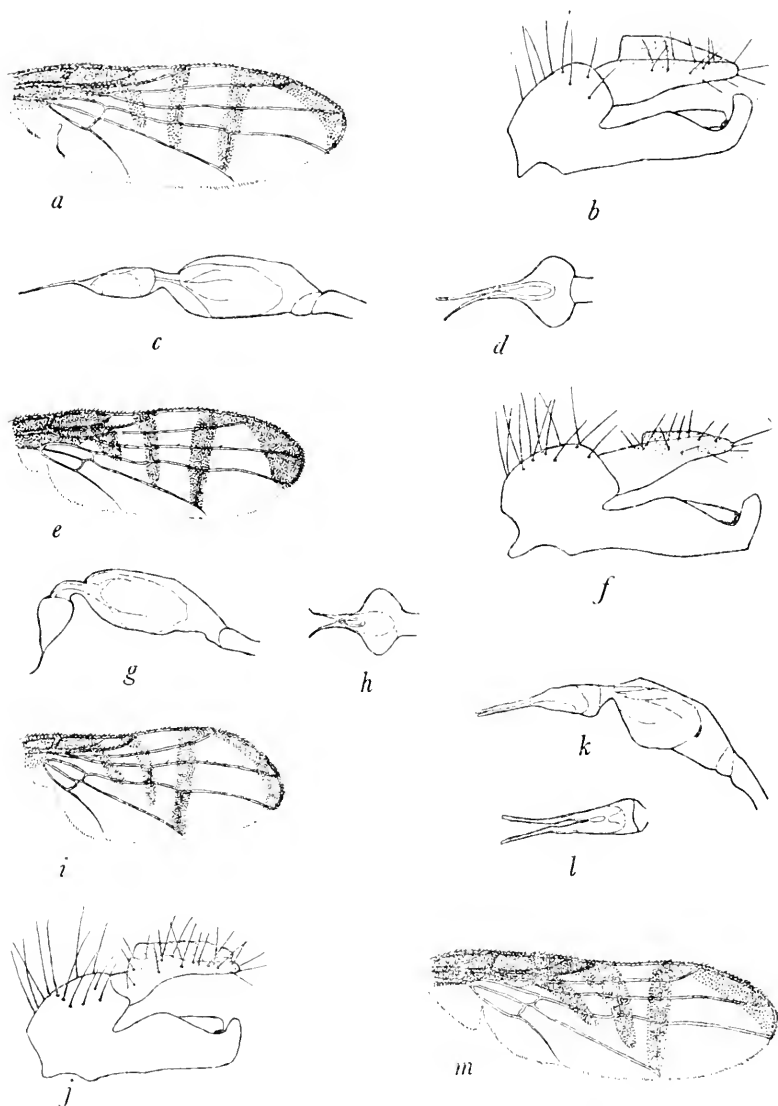


FIGURE 10.—*a-d*, *Rivellia micans* Loew: *a*, wing; *b*, lateral aspect of ninth tergite and proctiger of male; *c*, lateral aspect of aedeagus; *d*, dorsal aspect of aedeagus. *e-h*, *R. severini* Blanton: *e*, wing; *f*, lateral aspect of ninth tergite and proctiger of male; *g*, lateral aspect of aedeagus; *h*, dorsal aspect of aedeagus. *i-l*, *R. cognata* Cresson: *i*, wing; *j*, lateral aspect of ninth tergite and proctiger of male; *k*, lateral aspect of aedeagus; *l*, dorsal aspect of aedeagus. *m*, *R. socialis*, new species: wing.

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CHIGGERS OF THE GENUS *EUSCHÖNGASTIA* (ACARINA:  
TROMBICULIDAE) IN NORTH AMERICA<sup>1</sup>

By CHARLES E. FARRELL<sup>2</sup>

Introduction

In this paper the systematics of the genus *Euschöngastia* in North America are studied; 15 previously described species of *Euschöngastia* are redescribed; four previously described species are synonymized; nine new species of *Euschöngastia* are described (one of these having been divided into two subspecies); the morphology, geography, and ecology are considered in descriptions; a key for North American *Euschöngastia* is given; and the nomenclature of *E. oregonensis* (Ewing, 1929), *E. californica* (Ewing, 1925), and *E. setosa* (Ewing, 1937) are considered.

The author wishes especially to thank Dr. G. W. Wharton for his assistance throughout all phases of this work and Dr. H. S. Fuller for making available a manuscript copy of his paper on the Trombiculidae in the Oudemans collection that was published in

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1952. To all other persons who contributed materials or information, the author is also very grateful.

Chiggers are the larvae of trombiculid mites. They are the first active developmental stage in a life history which includes seven steps—egg, deutovum, larva, nymphochrysalis, nymph, imagochrysalis, and adult. Although very small, they can be seen by the naked eye. They are important parasites of terrestrial vertebrate animals, and they are the only stage of the trombiculid life cycle which is known to be parasitic. So far as is known, the two other active stages, nymph and adult, are predacious on small arthropods and arthropod eggs. Chiggers are widely distributed throughout the world. Several species are irritating pests of man. Wherever these species occur they have been given common names by the people living there; and they are known by reputation in places beyond where they are found.

Recently there has been a great awakening of interest in the study of chiggers. During World War II, under the medical urgency to find out everything possible concerning the vector of scrub typhus in the Pacific area, intensive investigations were begun. The interest aroused in this effort, which still continues, has spread to chiggers in general and has brought about rapid development in the systematics of the group.

Few areas have been studied intensively. Experience indicates that whenever a new region is investigated new forms as well as known species will be found. From September 1947 until December 1949 small mammals were trapped in Duke Forest, Durham County, and Orange County, N. C., for the purpose of determining the chigger populations. During the same time, chiggers removed from mammals collected by the Pennsylvania Mammal Survey were sent to Duke University for identification. A number of shipments were received from Ohio. The most numerous chigger specimens and species secured were of the genus *Euschöngastia*. With these collections as a nucleus, a study of the systematics of the genus for North America was undertaken.

### Review of the literature

**SYSTEMATICS:** There has been some confusion in the historical development of the family Trombiculidae. For many years the life histories of the mites were unknown; and, when different developmental stages were collected, they were named independently. Later, as life histories were determined, shifts of nomenclature were required by application of the law of priority.

In 1905 Berlese described *Trombicula minor*, a mite generally accepted to be a nymph with a body shaped like the figure 8. The monotypic genus *Trombicula* was erected for it in the family Trombidiidae. In 1912 Oudemans published a taxonomic summary of chiggers with descriptions and notes on all known species. He included these larvae in the genus *Microtrombidium* Haller, 1882, type species *M. purpureum* Haller, 1882, or in several genera he himself had created in 1910 and 1911. These genera also were in the Trombidiidae.

In 1916 the first successful rearing of nymphs from engorged chiggers occurred. In that year Kneissl reported rearing nymphs of the European pest chigger *Microtrombidium autumnalis* (Shaw, 1790). He observed they were shaped not like *Microtrombidium* but had the same form as *Trombicula*. He changed the name to *Trombicula autumnalis*. In 1917 Miyajima and Okumura made similar observations and changes with *Trombicula akamushi* (Brumpt, 1910). Later, other chiggers which had not been reared to nymphs were moved from *Microtrombidium* to *Trombicula* by various workers.

Ewing (1929d) established the subfamily Trombiculinae for the vertebrate-infesting chiggers, separating them from the arthropod-infesting mites of the family.

Willmann, in 1941, published the results of his examination of the type specimen of *Trombicula minor*. He determined it to be an adult female, not a nymph. However, this discovery had no effect on the classification. By this time adults of other species had been reared. These adults from cultures were congeneric with *T. minor*.

Ewing (1944a) proposed the new family Trombiculidae with two subfamilies, Trombiculinae and Hemitrombiculinae. Womersley (1944) added the subfamily Leeuwenhoekiiinae and in 1945 raised the group to full family status. Ewing (1946a) retained Leeuwenhoekiiinae as a subfamily and added the Walchiinae. Wharton (1947b) agreed with Ewing's determinations, added the subfamily Apoloniinae, and redefined the family on the basis of larval characteristics. In his new definition Wharton excluded the subfamily Hemitrombiculinae, which Ewing (1949) has said could well be made a separate family. At the same time Wharton gave a new diagnosis to the subfamilies based chiefly on the number of segments in the larval legs. With this development the classification of chiggers took on its present form at these intermediate levels. Wharton, Jenkins, et al. (1951) published a key

to the subfamilies and the genera. *Euschöngastia* is in the subfamily Trombiculinae.

The historical development of the genus *Euschöngastia* Ewing, 1938, has been confused only by differences of opinion or interpretation which have occurred during the recent growth in the systematics of chiggers. As groups of species were shifted into new genera in an effort to get more natural combinations, acarologists did not always view the problem in the same way and did not shift their nomenclature simultaneously and identically.

The oldest species included in *Euschöngastia*, as it is defined at present, is *E. trouessarti*, described by Oudemans in 1910 and placed in his new genus *Schöngastia*, type species *Thrombidium vandersandei* Oudemans, 1905. Only three species were included. Later, many species were added by several workers. Ewing (1929d) separated several species from *Schöngastia* and placed them in a new genus, *Neoschöngastia*, type species *Schöngastia americana* Hirst, 1921. *E. trouessarti* was included in the new genus in 1932.

In 1938 Ewing erected the monotypic genus *Euschöngastia* for his new species *E. americana*. His diagnosis in effect split *Neoschöngastia*.

In 1939 Womersley proposed a new genus, *Paraschöngastia* (type species *Neoschöngastia yeomansi* Gunther, 1939, by subsequent designation in Womersley and Heaslip, 1943), for a group of four species within *Neoschöngastia*.

Vitzthum (1942) considered *Euschöngastia* as a subgenus of *Schöngastia*, but subsequent authors have retained it as a full genus.

Ewing (1946b) showed that the four species placed in *Paraschöngastia* by Womersley were congeneric with the type species of *Neoschöngastia*. Therefore, *Paraschöngastia* Womersley, 1939, was a synonym of *Neoschöngastia* Ewing, 1929. Ewing then restricted *Neoschöngastia* to this newly formed group. This action excluded many species formerly in *Neoschöngastia*. To accommodate these excluded species, he erected a new genus, *Ascoschöngastia* Ewing, 1946, type species *Neoschöngastia malayensis* Gater, 1932. Workers outside the United States have followed Ewing's diagnoses of these genera.

However, Wharton (1948) has pointed out that the type species of *Ascoschöngastia* had an unusual morphological feature—the posterolateral setae lying off the scutum—which made it almost

unique. He held that *Ascoshöngastia* should be restricted to species with this character, and he expanded *Euschöngastia* to include all other species formerly placed in *Ascoshöngastia*. Fuller (1948) followed Wharton's concept and placed in *Euschöngastia* a number of old species, including *E. trouessarti*. In 1950 Ewing split off the monotypic genus *Boshellia* (type species *Neoschöngastia hirsuta* Boshell and Kerr, 1942). Recently, Fuller (1952), along with a list of the known species, gave a more complete diagnosis of the genus, which is accepted for this paper.

**DISTRIBUTION:** The genus *Euschöngastia* is widely distributed over the world. It has been found wherever collections have been made. In Ewing's original description only the genotype, *E. americana*, was included. Fuller (1948, 1952) has assembled most of the known species which were described originally under other generic names. Also, he has synonymized certain species with *E. indica*. Brennan (1947, 1948) described new species from North America. Recent *Ascoshöngastia* species of Lawrence (1949) from Africa are placed here in *Euschöngastia*. *Boshellia* Ewing, 1950, is here considered a synonym of *Euschöngastia*. If *Euschöngastia* later is split into subgenera, *Boshellia* will probably be valid at that level. All species are brought together in the following list, which summarizes by geographic regions the species of *Euschöngastia* described at the present time:

#### AUSTRALIA-ASIA

- E. antipodianum* (Hirst), Proc. Zool. Soc. London, vol. 12, pp. 175-176, figs. 6,c,f, 7,e,f, 1929.  
 Locality: South Australia.  
 Type host: *Rattus greyi* (Gray).
- E. bushlandi* (Philip), Journ. Parasit., vol. 33, pp. 387-390, figs. 1, 2, 1947.  
 Locality: Dutch New Guinea.  
 Type host: Bush fowl (*Megapodius*).  
 Holotype: U. S. National Museum No. 1780.
- E. cairnsensis* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 125, 128-129, pl. 10, fig. 7, text figs. 17A,B, 1943.  
 Locality: Queensland, Australia.  
 Type host: Rats.
- E. cairnsensis* var. *gateri* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 125, 129, pl. 10, fig. 8, 1943.  
 Locality: Queensland, Australia.  
 Type host: Rats.
- E. dasyerceri* (Hirst), Proc. Zool. Soc. London, vol. 12, pp. 174-175, text figs. 6B,E, 7A,B,D, 1929.  
 Locality: South Australia.  
 Type host: *Dasyercus cristicauda* (Krefft).

- E. debilis* (Gater), Parasitology, vol. 24, pp. 160-161, fig. 6, 1932.  
Locality: Federated Malay States.  
Type host: *Rattus cremoriventer cremoriventer* (Miller).  
Holotype (only): British Museum.
- E. derricki* (Womersley), Trans. Roy. Soc. South Australia, vol. 63, pp. 162-163, fig. 9A-E, 1939.  
Locality: Queensland, Australia.  
Hosts: *Rattus lutreolus* (Gray) and *R. assimilis* (Gould).
- E. echymipera* (Womersley and Kohls), Trans. Roy. Soc. South Australia, vol. 71, pp. 11-12, figs. 6A-C, 1947.  
Locality: New Guinea.  
Type host: *Echymipera cockerelli* (Ramsay).
- E. edwardsi* (Gunther), Proc. Linn. Soc. New South Wales, vol. 64, pp. 73, 82, 84, 86-87, figs. 13, 18, 26, 1939.  
Locality: New Guinea.  
Hosts: Bush fowl (*Megapodius duperreyi*) and bandicoot (*Echymipera cockerelli* (Ramsay)).  
Type slide: School of Public Health and Tropical Medicine, University of Sidney.
- E. foliata* (Gunther), Proc. Linn. Soc. New South Wales, vol. 65, pp. 251, 255-257, figs. 9-11, 1940.  
Locality: New Guinea.  
Type host: Scrub wallaby (*Macropus* [= *Thylogale*] *coxenii* (Gray)).  
Type slide: School of Public Health and Tropical Medicine, University of Sidney.
- E. globulare* (Walch), Geneesk. Tijdschr. Nederlandsch-Indië, vol. 67, pp. 929-930, 1927 [*vide* Sig Thor and Willmann, Das Tierreich, Acarina 3, Lief. 71b, p. 305, 1947].  
Locality: Celebes.  
Type host: Rats.
- Neoschöngastia guntheri* Womersley and Heaslip, Trans. Roy. Soc. South Australia, vol. 67, pp. 125, 126-127, pl. x, fig. 4, text fig. 15 A-B, 1943 (= *Euschöngastia lawrencei* (Womersley, 1952)). Not *Neoschöngastia guntheri* Radford, Parasitology, vol. 34, pp. 76, 77, fig. 101, 1942.  
Locality: Queensland, Australia.  
Type host: Rats.
- E. heaslipi* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 119-121, pl. ix, fig. 6, text fig. 12A-E, 1943.  
Locality: Queensland, Australia.  
Type host: Rats.
- E. hirsti* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 123, 125, pl. 10, fig. 1, text figs. 13A,B, 1943.  
Locality: Queensland, Australia.  
Hosts: Rats and *Melomys cervinipes* (Gould).
- E. indica* (Hirst), Bull. Ent. Res., vol. 6, pp. 187-188, figs. 5,6, 1915.  
Locality: Calcutta, India.  
Type host: *Nesokia* [= *Bandicota*] *bengalensis* (Gray and Hardwicke).  
Synonyms: *Trombicula muris* Walch, Geneesk. Tijdschr. Nederlandsch-Indië, vol. 64, p. 502, figs. 13-17, 1922 [*vide* Sig Thor and Willmann,



Das Tierreich, Acarina 3, Lief. 71b, p. 301, 1947]. *Neoschöngastia rattus* Womersley and Heaslip, Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 118–120, pl. 9, fig. 5, text figs. 11A,B, 1943. *Neoschöngastia cockingsi* Radford, Proc. Zool. Soc. London, vol. 116, p. 262, figs. 25,26, 1946.

*E. innisfailensis* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 107, 108–109, pl. 7, fig. 1, text figs. 9 A–B, 1943.

Locality: Queensland, Australia.

Type host: *Melomys littoralis* (Lönnberg).

*E. kohlsi* (Philip and Woodward), Amer. Journ. Trop. Med., vol. 26, pp. 159–161, 1946.

Locality: Mindoro, Philippine Islands.

Type host: *Rattus mindanensis mindanensis* (Mearns).

Type slide: U. S. National Museum No. 1526.

*E. lacunosa* (Gater), Parasitology, vol. 24, pp. 156–158, fig. 6, 1932.

Locality: Federated Malay States.

Type host: *Rattus sabanus vociferans* (Miller).

Type slide: British Museum.

Paratypes: U. S. National Museum.

*E. lanius* (Radford), Proc. Zool. Soc. London, vol. 116, pp. 261–262, figs. 23, 24, 1946.

Locality: Imphal, India.

Type host: Black-headed shrike (*Lanius nasutus* Scopoli).

*E. lorius* (Gunther), Proc. Linn. Soc. New South Wales, vol. 64, pp. 73, 82, 84, 86, figs. 12, 17, 25, 1939.

Locality: New Guinea.

Type host: Parrot (*Lorius roratus* subspecies).

Type slide: School of Public Health and Tropical Medicine, University of Sidney.

*E. mccullochi* (Womersley), Trans. Roy. Soc. South Australia, vol. 68, pp. 99–100, fig. 7 A–E, 1944.

Locality: New Guinea.

Type host: None. A single specimen collected on boots.

*E. melomys* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 107, 110–111, pl. 7, fig. 3, text figs. 10A,B, 1943.

Locality: Queensland, Australia.

Type host: *Melomys littoralis* (Lönnberg).

*E. mutabilis* (Gater), Parasitology, vol. 24, pp. 159–160, 1932.

Locality: Federated Malay States.

Type host: *Rattus sabanus vociferans* (Miller).

Type slide: British Museum.

Paratypes: U. S. National Museum.

*E. perameles* (Womersley), Trans. Roy. Soc. South Australia, vol. 63, pp. 160–162, figs. 7A–E, 1939.

Locality: Queensland, Australia.

Type host: Bandicoots.

*E. petrogale* (Womersley), Rec. South Australian Mus., vol. 5, pp. 215–217, figs. 92–95, 1934.

Locality: Musgrave Ranges, South Australia.

Type host: Wallaby.

- E. phascogale* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 127-128, pl. 10, fig. 6, text figs. 16A,B, 1943.  
Locality: Queensland, Australia.  
Type host: *Phascogale* sp.
- E. philippensis* (Philip and Woodward), Amer. Journ. Trop. Med., vol. 26, pp. 158-159, 1946.  
Locality: Mindoro, Philippine Islands.  
Type host: *Rattus mindanensis mindanensis* (Mearns).  
Type slide: U. S. National Museum No. 1525.
- E. queenslandica* (Womersley), Trans. Roy. Soc. South Australia, vol. 63, pp. 161-162, figs. 8A-E, 1939.  
Locality: Queensland, Australia.  
Hosts: *Rattus assimilis* (Gould), *R. youngi* Thomas, *R. lutreolus* (Gray), and *Melomys cervinipes* (Gould).
- E. shieldsi* (Gunther), Proc. Linn. Soc. New South Wales, vol. 66, pp. 157, 158-159, figs. 4, 5, 1941.  
Locality: New Guinea.  
Type host: Rufous scale-tail rat (*Melomys rubex* Thomas).  
Type slides: School of Public Health and Tropical Medicine, University of Sidney.
- E. similis* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 124, pl. 10, fig. 2, text figs. 14A,B, 1943.  
Locality: Queensland, Australia.  
Type host: Rats.
- E. smithi* (Womersley), Trans. Roy. Soc. South Australia, vol. 63, pp. 164, 165, figs. 10A-E, 1939.  
Locality: Queensland, Australia.  
Type host: *Rattus assimilis* (Gould).
- E. trichosuri* (Womersley), Trans. Roy. Soc. South Australia, vol. 63, pp. 159-160, 165, figs. 6A-E, 1939.  
Locality: Queensland, Australia.  
Type host: *Trichosurus vulpecula* (Kerr).
- E. uromys* (Womersley and Kohls), Trans. Roy. Soc. South Australia, vol. 71, pp. 10-11, figs. 5A-E, 1947.  
Locality: New Guinea.  
Type host: *Uromys lamington* Troughton.
- E. westraliense* (Womersley), Rec. South Australian Mus., vol. 5, p. 215, figs. 90, 91, 1934.  
Locality: Greenbushes, West Australia.  
Type host: Cat.
- E. womersleyi* (Gunther), Proc. Linn. Soc. New South Wales, vol. 65, pp. 251, 253, 254-255, figs. 6-8, 1940.  
Locality: New Guinea.  
Type host: Scrub wallaby (*Macropus* [= *Thylagale*] *coxenii* (Gray)).  
Type slide: School of Public Health and Tropical Medicine, University of Sidney.

## AFRICA

- E. aethomyia* (Radford), Parasitology, vol. 34, pp. 76, 78, fig. 102, 1942.  
Locality: Bathurst, South Africa.  
Type host: Graham's rock mouse (*Aethomys namaquensis grahami* (Roberts)).

- E. annulata* (Lawrence), Ann. Natal Mus., vol. 11, pp. 414-415, 465, 471, 482, text figs. 4a,b, 5a-c, 1949.  
Locality: Transvaal.  
Type host: Elephant shrew (*Elephantulus myurus jamesoni* Chubb).
- E. brevipalpis* (André), Bull. Mus. Hist. Nat. Paris, vol. 18, pp. 162-164, figs. 1-3, 1946.  
Locality: Carthage, Tunis.  
Type host: *Meriones shawi* (Rozet [= Duvernoy]).
- E. capensis* (Lawrence), Ann. Natal Mus., vol. 11, pp. 438, 465, 471, 484, text figs. 24a-c, 1949.  
Locality: Cape Province.  
Type host: *Eremias lineo-ocellata pulchella*.
- E. crociduræ* (Lawrence), Ann. Natal Mus., vol. 11, pp. 416-417, 465, 471, 482, text figs. 6a-c, 1949.  
Locality: Natal.  
Type host: Shrew (*Crocidura flavescens* (Geoffroy)).
- E. gerrhosauri* (Lawrence), Ann. Natal Mus., vol. 11, pp. 433-434, 465, 472, 483, text figs. 19a-c, 1949.  
Locality: Orange Free State.  
Type host: *Gerrhosaurus flavigularis flavigularis* Gray.
- E. kalaharica* (Lawrence), Ann. Natal Mus., vol. 11, pp. 434, 465, 472, 484, text figs. 20a-c, 1949.  
Locality: Kalahari.  
Type host: *Ichnotropis squamulosa* Peters, 1854.
- E. matoppoanus* (Lawrence), Ann. Natal Mus., vol. 11, pp. 435-436, 465, 471, 483, 484, text figs. 22a-c, 1949.  
Locality: South Rhodesia.  
Type host: *Platysaurus guttatus rhodesiensis*.
- E. ophicola* (Lawrence), Ann. Natal Mus., vol. 11, pp. 461, 465, 472, 484, text figs. 46a-c, 1949.  
Locality: Natal.  
Type host: House snake (*Boaedon lineatus*).
- E. origensis* (Lawrence), Ann. Natal. Mus., vol. 11, pp. 431-432, 465, 472, 484, text figs. 17a-c, 1949.  
Locality: Natal.  
Type host: *Tropidosaura essexi*.
- E. otomyia* (Radford), Parasitology, vol. 34, pp. 76, 77, fig. 100, 1942.  
Locality: South Africa.  
Type host: Swamp rat (*Otomys tugelensis pretoriae* Roberts).
- E. rhodesiensis* (Lawrence), Ann. Natal Mus., vol. 11, pp. 437, 465, 472, 483, text figs. 23a-c, 1949.  
Locality: Southern Rhodesia.  
Type host: *Mabuya 5-taeniata margaritifera*.
- E. transvaalensis* (Lawrence), Ann. Natal Mus., vol. 11, pp. 435, 465, 472, 484, text figs. 21a-c, 1949.  
Locality: Transvaal.  
Type host: *Ichnotropis squamulosa* Peters.
- E. tropidosauri* (Lawrence), Ann. Natal Mus., vol. 11, pp. 432-433, 465, 472, 484, text figs. 18a-c, 1949.  
Locality: Natal.  
Type host: *Tropidosaura essexi*.

*E. viperina* (Lawrence), Ann. Natal Mus., vol. 11, pp. 462, 465, 472, 484, text figs. 47a-c, 1949.

Locality: Pietermaritzburg.

Type host: Night adder (*Causus rhombeatus*).

#### EUROPE

*E. xerothermobia* (Willmann), Zeitschr. Parasitenk., vol. 12, pp. 643-644, 1942.

Locality: Graz, Steiermark, Austria.

Host: Unknown.

#### MÉXICO

*E. nuñezi* (Hoffmann), Rev. Inst. Sal. Enf. Trop., vol. 5, pp. 221-225, figs. 1-4, 1944.

Locality: México.

Host: Man.

Type slide: Instituto de Salubridad y Enfermedades Tropicales de México.

#### SOUTH AMERICA

*E. dasypsectae* (Ewing), Proc. Biol. Soc. Washington, vol. 50, p. 168, 1937.

Locality: Colombia.

Type host: Agouti (*Dasyprocta variegata* Tschudi).

Type slide: U. S. National Museum No. 1260.

*E. columbiae* (Boshell and Kerr), Rev. Acad. Colombiana Cienc. Exact. Fis. Nat., vol. 5, pp. 7, 16, 18, pl. 10, figs. 6-8, 1942.

Locality: Colombia.

Type host: *Proechimys chrysaolus* (Thomas).

*E. guyanensis* (Floch and Abonnenc), Publ. Inst. Pasteur Guyane Terr. l'Inini, vol. 20, pp. 2, 13-16, fig. 5, 1941.

Locality: French Guiana.

Hosts: Dog and man.

Type slide: Institut Pasteur de la Guyane et du Territoire de l'Inini No. 158.

*E. hirsuta* (Boshell and Kerr), Rev. Acad. Colombiana Cienc. Exact. Fis. Nat., vol. 5, pp. 7, 19, pl. 1, figs. 4, 5, 1942.

Locality: Colombia

Type host: *Proechimys chrysaolus* (Thomas).

Type slide: U. S. National Museum No. 53018.

*E. nasuae* (Boshell and Kerr), Rev. Acad. Colombiana Cienc. Exact. Fis. Nat., vol. 5, pp. 7, 19-20, pl. 1, figs. 1-3, 1942.

Locality: Colombia.

Type host: *Nasua candace* Thomas.

Type slide: U. S. National Museum No. 53019.

*E. phylloti* Wharton, Psyche, vol. 55, pp. 89, 90-92, 99, figs. 1 A-H, 1948.

Locality: Caccachara, Perú.

Type host: *Phyllotis darwini* (Waterhouse).

Type slide: Museum of Comparative Zoology No. 3026.

*E. trouessarti* (Oudemans), Ent. Ber., Amsterdam, vol. 3, p. 87, 1910 [*vide* Sig Thor and Willmann, Das Tierreich, Acarina 3, Lief. 71b, p. 311, 1947].

Locality: Southern Brazil.

Type host: *Didelphis* [= *Philander*] *opossum* Linnaeus.

## UNITED STATES

- E. blarinae* (Ewing), Proc. U. S. Nat. Mus., vol. 80, pp. 11-12, 19, pl. 1, fig. 1, 1931.  
Locality: Rock Creek Park, Washington, D. C.  
Type host: *Peromyscus leucopus* (Rafinesque).  
Type slide: U. S. National Museum No. 1018.
- E. californica* (Ewing), Amer. Journ. Trop. Med., vol. 5, pp. 261, 262, 1925.  
Locality: Topaz, Calif.  
Type host: Ground squirrel.  
Type slide: U. S. National Museum No. 893.
- E. cordiremus* Brennan, Journ. Parasitol., vol. 34, pp. 465, 470, 471, 477, figs. 4A-D, 11, 1948.  
Locality: Ravalli County, Mont.  
Type host: *Peromyscus maniculatus artemisiae* (Rhoads).  
Type slide: Rocky Mountain Laboratory.
- E. criceticola* Brennan, Journ. Parasitol., vol. 34, pp. 465, 473-474, 476, 477, figs. 6A-D, 13, 1948.  
Locality: Ravalli County, Mont.  
Type host: *Peromyscus maniculatus artemisiae* (Rhoads).  
Type slide: Rocky Mountain Laboratory.
- E. guntheri* (Radford), Parasitology, vol. 34, pp. 76, 77, fig. 101, 1942.  
Locality: Antonito, Colo.  
Type host: *Cony* [*Ochotona*].
- E. hamiltoni* Brennan, Journ. Parasitol., vol. 33, pp. 251-252, figs. 4A-D, 1947.  
Locality: Millertown, N. Y.  
Type host: *Eptesicus fuscus fuscus* (Beauvois).  
Type slide: Rocky Mountain Laboratory.
- E. lacerta* Brennan, Journ. Parasitol., vol. 34, pp. 465, 467-468, 477, figs. 2A-D, 9, 1948.  
Locality: Camp McQuaide, Santa Cruz County, Calif.  
Type host: *Sceloporus occidentalis occidentalis* (Baird and Girard).  
Type slide: Rocky Mountain Laboratory.
- E. luteodema* Brennan, Journ. Parasitol., vol. 34, pp. 465, 470, 472-473, 477, figs. 5A-D, 12, 1948.  
Type locality: Ross's Hole, Ravalli County, Mont.  
Type host: *Marmota flaviventer nosophora* Howell.  
Type slide: Rocky Mountain Laboratory.
- E. oregonensis* (Ewing), Proc. Ent. Soc. Washington, vol. 31, p. 11, 1929.  
Locality: Corvallis, Oreg.  
Type host: Mole.  
Type slide: U. S. National Museum No. 990.
- E. peromysci* (Ewing), Ent. News, vol. 40, pp. 296-297, 1929.  
Locality: Sturbridge, Mass.  
Type host: *Peromyscus leucopus noveboracensis* (Fischer).  
Type slide: U. S. National Museum No. 993.  
Synonyms: *Neoschöngastia brevipes* Ewing, Proc. U. S. Nat. Mus., vol. 80, art. 8, pp. 16, 19, pl. 2, fig. 4, 1931. *Neoschöngastia signator* Ewing, Proc. U. S. Nat. Mus., vol. 80, art. 8, pp. 14-15, 19, pl. 2, fig. 1, 1931.

- E. pipistrelli* Brennan, Journ. Parasitol., vol. 33, pp. 249-251, figs. 3A-D, 1947.  
Locality: Mud Cave, Stone County, Mo.  
Type host: *Pipistrellus subflavus subflavus* (F. Cuvier).  
Type slide: Rocky Mountain Laboratory.  
Synonym: *E. miricoxa* Brennan, Journ. Parasitol., vol. 34, pp. 465, 468-469, 477, figs. 3A-E, 10, 1948.
- E. samboni* (Radford), Parasitology, vol. 34, pp. 76-77, fig. 99, 1942.  
Locality: Ross's Hole, Mont.  
Type host: *Pika* [*Ochotona*].
- E. sciuricola* (Ewing), Amer. Journ. Trop. Med., vol. 5, pp. 261, 262, 1925.  
Locality: Florence, Mont.  
Type host: *Sciurus* [= *Tamiasciurus*] *hudsonicus richardsoni* Bachman.  
Type slide: U. S. National Museum No. 892.  
Synonym: *E. americana* Ewing, Journ. Washington Acad. Sci., vol. 28, p. 293, 1938.
- E. setosa* (Ewing), Proc. Biol. Soc. Washington, vol. 50, pp. 170, 171, 1937.  
Locality: Okefenokee Swamp, Ga.  
Type host: *Peromyscus gossypinus gossypinus* (LeConte).  
Type slide: U. S. National Museum No. 1256.

**CULTURE AND LIFE HISTORY:** Knowledge of the life history of trombiculid mites has been acquired mostly by rearing them in the laboratory. The Japanese were the first active workers on chigger culture. During the early years of this century, they were trying to determine the development of the vector of tsutsugamushi disease. However, the first report of rearing chiggers was that of Kneissl (1916), who obtained nymphs in a culture jar with soil from engorged larvae of *Trombicula autumnalis*. The next year, 1917, Miyajima and Okumura reared *T. akamushi* through all its life cycle. They described and figured the deutovum, larva, nymphochrysalis, nymph, imagochrysalis, and adult, but they failed to find the egg. They used soil in jars for their cultures, apparently, and gave the nymphs and adults pieces of potato and mellon as food. Hatori (1919) described rearing engorged chiggers through the adult stage in vitro with soil, but attempts to culture them on vegetable matter in vitro failed. Ewing (1925a) reported the first effort at rearing chiggers in the United States. He obtained larvae from a wild-caught female *Trombicula alfreddugèsi* (Oudemans, 1910) which he kept on a disc of cork placed on sand in a vial. Springtail fecal pellets and a dead springtail were offered as food. Miller (1925a, 1925b) reported obtaining adults of *T. alfreddugèsi* from engorged larvae shed from infested snakes kept in suitable "aquaria" with soil. However, Ewing (1944b) stated that Miller reared nymphs, not adults. Ewing (1926a) reared 28 nymphs and two adults of

*T. alfreddugèsi* from chiggers of four infested Carolina terrapins. The terrapins were placed in containers with sand on the bottoms. The chiggers detached easily. One nymph was placed in a small cell with cockroach feces. It died after 31 days without transforming. Ewing (1926b) obtained many nymphs and a single adult of *Hannemania hylae* (Ewing, 1925), subfamily Leeuwenhoeekiinae, from engorged larvae in soil on which their tree frog hosts had been kept. He described the nymph and adult and figured all three active stages. André (1930) reported rearing a nymph of *T. autumnalis*. Keay (1937) reared a "considerable number" of nymphs from fully engorged *T. autumnalis* larvae placed in sterilized soil in an atmosphere saturated with moisture. Nymphs were obtained by Gunther (1939b) from engorged *Trombicula* sp. larvae placed in jars with moist, sterile soil. In 1944 Ewing (1944b) reported having reared nymphs of *T. alfreddugèsi* from larvae engorged on toads. At this time he summarized the life cycle of this species as it was known—the egg removed from the abdomen of an adult female, the larva, the nymph, and the adult.

The first successful culturing of chiggers in which reproduction occurred and subcultures were established was reported by Melvin (1946) and Michener (1946), working with *T. batatas* (Linnaeus, 1758). They worked in the same laboratory and their methods were similar. Both used baby chicks as hosts for the larvae. Engorged larvae were placed in bottles or jars containing soil mixed with chicken manure in which the mites completed their development. No food was offered in addition to the chicken manure-soil mixture. Michener described and figured the seven stages of the life cycle.

None of these workers determined the food requirements of the free-living stages. Then Wharton (1946) and Wharton and Carver (1946), working with *Euschöngastia indica*, discovered that insect eggs were suitable food for the nymphs and adults. The feeding process was observed with a dissecting microscope. *Drosophila*, *Culex*, and *Aedes* eggs and the eggs of other species were used. Adults were observed, also, to feed on their own eggs and on ant larvae. What appeared to be an unsuccessful attempt at cannibalism by one nymph upon another was seen once. Nymphs and adults were obtained from engorged larvae, and these reared adults produced larvae. Wharton (1946) gave descriptions of all stages, figures of egg, deutovum, larva, nymphochrysalis, and nymph, and photographs of all stages except the egg. After the discovery of insect eggs as food for the free-

living nymphs and adults, culturing of trombiculids was much facilitated.

Jenkins (1947) published a method, incorporating the results of other workers, by which three species of *Trombicula* had been cultured successfully. He used terrapins and snakes as hosts for larvae, soil as a medium, and mosquito eggs as food for nymphs and adults. Jayewickreme and Niles (1947) outlined a method which employed cellulose wadding as a medium, mice as hosts for larvae, and *Culex* eggs and freshly killed collembolans as food for the free-living stages. Farrell and Wharton (1949) featured an improved culture jar, golden hamsters as hosts, and vermiculite as a medium. The most recent information on culturing was by Lipovsky (1951). He reported having reared about 25 species of trombiculids to the adult stage. He obtained larvae from about 15 species of these reared adults. The species were not named but were stated to represent six known genera, including *Euschöngastia*, and two undescribed genera. In Lipovsky's method a collembolan, *Sinella curviseta* Brook, fed on active dried yeast pellets was maintained in the chigger cultures. The nymphal and adult trombiculids fed on the collembolan eggs or the active stages of the insect.

**ECOLOGY AND BEHAVIOR:** Literature concerned directly with the ecology and behavior of trombiculids is scant. Much ecological information has been acquired in the basic collection data accompanying all specimens and their descriptions. These data consist of locality, date, and host. Occasionally notes have been added which state the areas infested on the host. Other valuable information, including the fundamental details of life history and food requirements, has come from the efforts to culture chiggers.

Riley (1873) gave one of the first ecological notes on pest chiggers of the United States. He said their habitat was rank herbage and grass in forest openings or along streams. He stated that chiggers bury themselves in the skin and that "The normal food . . . of these mites must, apparently, consist of the juices of plants, and the love of blood proves ruinous to those individuals which get a chance to indulge it . . . . They soon die—victims of their sanguinary appetite." Riley repeated these comments in 1887. Chittenden (1915) associated pest chiggers with briar patches and gave a life cycle which omitted the nymph. He confused chiggers with arthropod-infesting trombidids. He stated chiggers burrow under the skin and apparently gorge with blood. In 1915 Banks gave a brief account of pest chiggers, listing common names. He said, "They enter pores of the skin and pro-



duce inflamed spots. It is an unnatural situation for the mites and they soon die." Howard (1918) said that chiggers do not bury themselves when engorging but insert mouthparts and fill with blood, and after engorging fall off.

Ewing (1921) gave an account of early investigations on geographic and seasonal distribution, habitat preference, manner of attaching to human skin, and related topics. The normal hosts were not known. Ewing tried to find chiggers feeding on plants, although he did not believe they used plant food. His efforts to find them on insects and small mammals failed also. He found many attached to a shed snakeskin from which they were unable to free themselves, and he concluded snakes were not normal hosts. He described and figured chiggers attached to the surface of human skin, and said they fed on lymph of the "true skin." Miller (1925a and 1925b) showed snakes to be normal hosts. Ewing (1926a) found the Carolina terrapin to be an important host; and later he (1929b) added the rabbit and several species of birds to the list.

Keay (1937), clearly making a study of the ecology of *Trombicula autumnalis*, determined something of its seasonal distribution and host preferences. She found its local distribution sporadic but was unable to determine limiting factors in vegetation or soil, although most records were from calcareous soil. Buxton (1945) made similar comments on the natural history of this species.

In 1943, *Acomatacarus paradoxa* (André) Brennan, 1949, was described from scorpion, an exception to Ewing's ecological diagnosis of the family Trombiculidae.

Much information has been assembled by the groups working with scrub typhus. Blake, Maxcy, et al. (1945) gave an account of the habits of free and attached chiggers, the results of studying several species in New Guinea. Mackie, Davis, et al. (1946), in Assam and Burma, found some evidence of seasonal activity of the mites in relation to rains by using the number of cases of the disease as an index. Audy (1947a) pointed out the localized distribution of *T. deliensis* Walch, 1922, could have been the result of ecological demands by the free-living stages. He stated the mites were not conspicuous around the burrows of their rat hosts but were most abundant in "fringe habitats," the intermediate areas between forest and open scrub. During dry seasons he found the chiggers only in moist areas, but the populations increased greatly after the onset of the rains. Audy (1947b) reemphasized the peak incidence of *T. deliensis* larvae during the

rains and pointed out the importance of their principal hosts in their patchy distribution.

Wharton (1946) found the adults of *Euschöngastia indica* living in the nests of rats in trees and on the ground. The rats were parasitized by the larvae. Wharton studied the biological factors of the environment and gave lists of associated organisms. Jenkins (1948a) gave an account of three species of *Trombicula* which affect man in the United States, with data on seasonal activity, distribution, habitat preference, hosts, and life cycle included.

Cockings (1948), in giving methods for collecting free larvae of *T. autumnalis* in the field and for recovering engorged larvae from hosts, indicated the larvae reacted positively to light. Also, he made observations on the vertical distribution of the adults in the soil and found a correlation with temperature and rainfall. Jenkins (1948b) made laboratory investigations of the reactions of larvae of *T. alfreddugèsi* and *T. splendens* Ewing, 1913, to various physical factors. He found activity to be initiated in the chiggers by disturbances in the environment. The direction of movement appeared to be determined by light. The reaction was positive for previously dark-conditioned larvae and negative for previously light-conditioned larvae. The rate of movement was determined primarily by temperature.

**MEDICAL IMPORTANCE:** There is considerable literature on *Trombicula* which attack man but very little on *Euschöngastia* which attack man. Floch and Abonnenc (1941) stated that *E. guyanensis* was a parasite on man. Hoffmann (1944) described *E. nuñezi* from human hosts. Nuñez (1947) gave a full account of the six cases of trombidiasis in one family from which Miss Hoffmann's specimens were collected.

**DESCRIPTION REVIEW:** The manner of describing chiggers has fluctuated somewhat as different workers have stressed various characters. Oudemans (1912) gave a good description of the whole mite, including some of the specialized setae of the legs. Later descriptions frequently were less adequate. In 1925 Ewing (1925b) emphasized the palpal setae, in 1937 he emphasized the dorsal setae of the body, and in 1938 he used the branches on the palpal claw to separate genera. Gunther (1940) noted unusual body setae. Methlagl (1927) used two formulas—the convexity factor and the ratio of length to width—to describe scuta, but other workers have not followed his method. Womersley and Heaslip (1943) introduced a series of measurements of the

scutum, the Standard Data. Directions for photomicrography of the scutum and the whole mite were given by Gill and Parrish (1945). Wharton (1947a) outlined the development of chigger description and presented his method of recording morphological units in a series of drawings; and in 1948 he called attention to the value of the specialized setae of the legs in grouping and identifying species of chiggers. Wharton, Jenkins, et al. (1951) contributed a list of characters useful in descriptions of both larvae and adults, with a glossary of terms. Through the years most workers have used drawings to supplement their written descriptions.

### Materials and methods

The chiggers collected in the Duke Forest area for this study were taken mostly from infested small mammal hosts which were trapped during a program extending from September 1947 to December 1949. When transportation facilities permitted, traps were set on Saturday afternoon of each week and were picked up early on Sunday morning. During Christmas and spring vacations, trapping usually was continuous and traps were visited each morning. Areas to be trapped were determined by reference to the Forest Cover Maps published by the Duke University School of Forestry on July 1, 1944. The system of compartment identification used on these maps has been followed in this paper.

Museum special snap traps, supplemented by one or two ordinary rat traps, made up the standard trap line. The number of traps set varied, but it was usually about 35. The bait generally used was oatmeal moistened with saliva and pressed on the trigger. Two types of box traps were used infrequently—a single trap with a drop door, baited with apple or carrot, for rabbits, and several box traps with inward swinging hardware cloth doors, baited with oatmeal or carrot, for mice. On two occasions lines of steel traps were run continuously to collect fur bearers. One line was kept out for eight days in February 1949. A second line was operated for 16 days in November and December 1949. A shotgun was used to collect squirrels, rabbits, and bats; small mammal highway casualties were picked up; and gifts of vertebrates were accepted from other workers in the area.

No organized collecting was done for vertebrates other than mammals, but they were collected occasionally. Reptiles, particularly, were collected whenever opportunity offered.

Trapped mammals were examined immediately for ants, which were removed. All specimens except fur bearers were then placed in No. 3 or No. 5 paper bags. The mouth of the bag was closed by twisting the paper tightly. Specimens were separated as to locality and species during the winter months. Usually, in late spring, summer, and fall each specimen was placed in a separate bag. Fur bearers were placed in burlap or cloth bags or were taken to the laboratory uncovered.

In the laboratory the paper bags and the specimens were examined for chiggers. The bags were torn open, smoothed out, and inspected with hand lens or dissecting microscope. The mammals were examined with the aid of the hand lens or the dissecting microscope, with particular attention being given to the ears in all species and to the posterior portion of the venter and the rump on shrews. Chiggers often were found crawling on the fur.

Some chiggers were removed directly from their places of attachment by use of a dissecting needle, but it was preferred to permit them to free themselves. At the beginning of the second winter's trapping, it became standard routine first to examine the hosts visually and to remove chiggers already detached. Hosts not preserved and freshly prepared study skins were then placed on wire screens in funnels over water. This was an adaptation of the Berlese funnel. A low rack was made which held seven funnels. Glass and metal funnels of standard shape and funnels with straight sides were used. These funnels were 20 to 24 cm. in diameter. Screens of hardware cloth were cut to fit about 2.5 cm. inside the funnels. Beakers, finger bowls, and the bottoms of weighing bottles half filled with water were placed under the funnels to receive the chiggers when they detached. To prevent migration of chiggers between funnels and between collecting dishes, benzol benzoate was applied to the rack between the funnels and to squares of insulation board on which the collecting dishes were placed. A bent dissecting needle was used to pick up chiggers. To be effective in removing chiggers from fur or paper, the tip of the needle was moistened with water.

Chiggers which were to be used alive, if not immediately, were placed in special vials (Farrell and Wharton, 1948) made by lining 25 x 15 mm. shell vials with a mixture of plaster of Paris 90 parts by weight and activated charcoal 10 parts by weight. Stoppers were smooth No. 4 corks. The lining was kept moist with distilled water. Chiggers to be preserved were mounted

directly on slides or were stored in small glass tubes in 85 percent ethyl alcohol.

Records were kept of hosts and chiggers by collections. A collection of hosts consisted of all host specimens of one species taken in one locality on one date. A collection of chiggers consisted initially of all chiggers taken from one collection of hosts. Later, the separate species of chiggers were identified. The number of individual hosts infested was determined for each collection by direct examination or by recovering chiggers over water; but chiggers were identified from collections of hosts, not from the separate host specimens. In Duke Forest a compartment was considered a locality. If a single trap line extended through two compartments, it was considered to lie in one locality unless a stream separated the compartments. In the latter case the line was considered to lie in two localities. Outside Duke Forest, streams or main highways were considered to be boundaries separating the localities.

Unattached chiggers were collected through Berlese funnels from soil and other materials from various ecological niches. A battery of four funnels, each 48 cm. wide by 58 cm. high, was used. A rack supporting four electric lamps in large reflectors was constructed to supply top heat for drying the materials placed on the funnels. Small beakers and bottoms of weighing bottles were half filled with water and placed under the funnels to receive the organisms. The glassware rested on squares of insulation board swabbed with benzol benzoate. Unattached chiggers obtained through Berlese funnels were handled in the same manner as chiggers from hosts.

Chiggers contributed by collectors working on other projects usually were shipped alive to the laboratory in the special charcoal-lined vials. The most extensive of these collections were those of the Pennsylvania Mammal Survey, which continued throughout the year. However, these collectors generally made shipments only when infestations on mammalian hosts were highest.

Living chiggers were used extensively in efforts to establish cultures. Eighty-three cultures of *Euschöngastia* were started. A variety of containers were tried. Standard pint canning jars and tall 12-ounce bottles were tried with bottoms removed and the openings filled with a mixture of plaster of Paris 90 parts by weight and Merck's animal charcoal 10 parts by weight. In use these containers were placed in small finger bowls. Wide-

mouth pint canning jars, jars measuring 140 mm. by 135 mm., weighing bottles, and 4-ounce amber jars were used with bottoms intact. The plaster-charcoal mixture was poured into these, forming a base which varied in thickness from 5 mm. in the weighing bottles to 35 mm. in the larger containers. Some wide-mouth jars were completely lined with the mixture. One weighing bottle and one wide-mouth pint jar were lined with moist cellulose wadding. Some containers were stoppered with cotton plugs, others with solid lids. The plaster-charcoal was kept moist with distilled water to maintain high humidity within the cultures.

Some cultures were established in containers without the addition of media or substrates for the mites. In most cultures some material through which the mites could move was added. Screened soil from forest and open field was used. In earlier cultures a film of animal charcoal was placed on the plaster-charcoal base, and the soil was poured over this. Mixtures of washed sand and soil and stratified sand and soil were tried. Depths of these media varied from 2 or 3 mm. to 50 mm. Some were autoclaved; others were not. Decayed wood from an oak log, leaf mold, and humus were used without autoclaving. Vermiculite was used alone or mixed in equal parts by volume with humus or the debris collected under the bark of a decaying tree.

A variety of foods were tried in an effort to find a kind that the free-living stages would accept. The foods tried were pieces of white potato, pieces of apple, moist fiber from a *Neotoma floridana* (Ord) nest, mouse feces, ground beef, beef liver, flying squirrel flesh, gelatin, ground beef in gelatin, beef liver in gelatin, and pieces of earthworm. Ant larvae, bisected ant pupae, and decapitated *Onychiurus* sp. and termites were offered. A female *Pediculoides* mite producing young was placed in one culture. Other offerings were *Aedes* eggs, *Aedes* eggs sterilized in White's solution (Trager, 1937), *Aedes* eggs ruptured with a needle, dissected *Aedes* eggs and ovaries, *Culex* eggs, ruptured *Culex* eggs, large bug eggs punctured with a needle, dissected grasshopper eggs, spider eggs, eggs dissected from a small fly, dissected soldier beetle eggs, dissected ant ovary, blowfly eggs, crushed blowfly eggs, blowfly maggots hatched in the culture, and May fly eggs. Living *Onychiurus* sp. and other living unidentified apterous insects in variety were placed in cultures. Fresh forest soil with all its contained organisms was used. *Euschöngastia* nymphs were placed in *Trombicula alfreddugèsi*.

cultures which were reproducing. They were placed, also, in a jar with soil in which a deer mouse, infested with mites and fleas, was kept. *Sinella curviseta* Brooks, a collembolan, from Mr. Louis Lipovsky, University of Kansas, was maintained in many later cultures. *Onychiurus* sp. and *S. curviseta*, fed on Brewer's yeast powder, reproduced in cultures, laying numerous spherical eggs.

Most cultures were kept in a darkened cabinet at room conditions. Three were held in an incubator at 30° C., three were kept at 5° to 7.5° C., and one at 10 to 15° C.

To start cultures, engorged larvae usually were held in special vials until they had transformed into nymphs. The vials were flooded with distilled water. The nymphs floated to the top and were transferred by needle into culture jars. Most cultures were inspected at daily to weekly intervals, and food was offered. Distilled water was added, as judged necessary. When cultures were discontinued the jars were flooded with tap water. Dead nymphs were recovered and preserved. Living nymphs were preserved or transferred to other cultures. Identity of nymphs in most cultures was determined by sampling the lot of chiggers from which the nymphs were obtained.

A few living chiggers were used to obtain nymphs of known species. For these determinations, each engorged chigger was placed in a separate special vial. When it had metamorphosed into a nymph, the vial was flooded with water. The nymph and the cast larval skin were picked from the surface of the water. The skin was mounted on a microscope slide and from it the species of the nymph was determined.

Unattached *E. peromysci* from soil were placed on three white mice. The hosts were held in small beakers. Chiggers were removed by dissecting needle from the water surface in the collecting vessels and placed on the fur of the hosts. Hosts were retained about three hours in the beakers and then were put in small cages in funnels over water. When the chiggers detached they were collected from the surface of the water.

A few unattached *E. peromysci* collected from soil were used to determine if they would attach to man. A small hole about 5 mm. in diameter was cut in the center of a piece of adhesive tape measuring 50 mm. by 80 mm. A glass ring, 17 mm. by 5 mm., was placed over the hole on the adhesive side. A piece of fine silk, 30 mm. in diameter, was placed on the glass ring and made concave by finger pressure. A drop of distilled water was placed

in the center of the silk. Two or three chiggers were removed by dissecting needle from the surface of the water in the collecting vessel and floated on the drop of water. The palmar surface of the forearm was placed on top of the assembly, which was secured in place by the adhesive tape. From 4½ to 7 hours later the applications were removed, and the areas were examined with a dissecting microscope.

Chiggers were used in experiments to determine their rates of locomotion during falling and rising temperatures. Two species of chiggers, *T. alfreddugèsi* with a warm weather distribution and *E. peromysci* with a predominantly cold weather distribution, were compared in the tests. Clean glass tubes, 76 mm. or 40 mm. by 7 mm., were used to confine the chiggers. One or two specimens were placed in each tube. The two species were placed in separate tubes. The tubes were stoppered at each end with clean rubber stoppers. An apparatus to produce a slowly falling temperature was made by mixing salt and crushed ice in a trough. A shelf of hardware cloth was suspended in the freezing mixture. A small finger bowl was filled with brine solution and placed on the shelf. The tubes containing the chiggers and the bulb of a thermometer were submerged in the finger bowl. To obtain rising temperatures, the finger bowl was removed from the freezing mixture to room temperature. To produce temperatures above that of the room, hot water from the laboratory supply line was led into the trough by a length of hose; and the finger bowl was returned to the hardware cloth shelf. Light from a dissecting microscope lamp was directed on the chiggers, and a dissecting microscope with an ocular micrometer was used to observe them. The chiggers were timed with a stop watch as they moved through the tubes.

In a second test a dead *Peromyscus leucopus* (Rafinesque), infested with chiggers, was placed in a freezing chamber at  $-4.5^{\circ}$  C. on Mar. 20, 1949. It remained in the chamber at that temperature until it was removed on Apr. 27, 1949, and placed in a funnel over water.

A selective process was used to determine chiggers for preservation on slides. Every effort was made to obtain specimens of all species represented in a collection. Whenever there were many specimens from which a sample was to be mounted on slides, a search was made for different forms. The dissecting microscope was frequently used to examine living material. It was always used with specimens already preserved in alcohol. Any specimens



which appeared different by reason of color, conformation, or number of setae were mounted on slides. Specimens of different engorgements were selected. Chiggers were preserved for study in polyvinyl alcohol with lactic acid on microscope slides.

A Spencer research microscope was used to study the slides. It was equipped with low power and oil immersion apochromatic objective lenses, high dry and oil immersion dark contrast phase contrast objective lenses, and a turret condenser. Compensating oculars of 5x and 10x were used. Each lens system had its own sphere of usefulness. The phase contrast objectives were most helpful for surface detail and body setae in fresh preparations, but in older and overcleared slides were useful for all structures. Drawings and measurements were made with the aid of a reticule carried in one 10x ocular. To be used for measuring, the reticule was calibrated with a stage micrometer. The edge of one square equaled 61.5 microns with the low power apochromatic objective, 14.5 microns with high dry phase, 6.8 microns with the oil immersion apochromatic, and 6.3 microns with the phase oil immersion. Drawings were made on blue-line graph paper ruled to one-fifth of an inch. Photomicrographs were made with a Spencer photomicrographic camera on the microscope. The oil immersion phase contrast lens and a 5x compensating ocular were used for all photomicrographs.

All chigger identifications were made at Duke University. Dr. G. W. Wharton identified two new species of *Trombicula*, the *Trombicula* near *akamushi*, and the new genus. Other chigger identifications were made by the author.

Chiggers of the genus *Euschöngastia* were first sorted out strictly on morphology. A key was developed by which species known in the literature could be identified. Names from the literature were applied temporarily to forms when descriptions seemed to agree with observed morphology. The key was altered and enlarged as the study proceeded. A catalog was kept of all specimens and notes were made of variations and anomalies. After the material had been sorted, each series of specimens was reexamined. If the series was small, all specimens were studied. If the series was large, it was studied by sampling. The sample was taken by picking slides from the slide box at regular intervals. In some cases additional samples were needed from certain geographic areas. They were taken at random from the slide box. More detailed notes, including setal counts and measurements of morphological features were made. Within the limits of the

sample and the methods used, the extent of variation in the selected morphological features was determined for each form. Geographic, seasonal, and host distributions were considered.

Type material was studied at the U. S. National Museum. Cotypes were borrowed from the Museum and paratypes were borrowed from the Rocky Mountain Laboratory. Duke University material was compared with these specimens and valid names were determined for the species already described. Specimens of *Euschöngastia* species which did not occur in the collections assembled at Duke University were studied at the U. S. National Museum or where borrowed from the Museum and the Rocky Mountain Laboratory.

Amount of rainfall and temperatures of the air, soil surface, and subsoil in the Duke Forest area were obtained from a station maintained by Dr. G. W. Wharton on Duke Homestead Road. The temperatures were recorded continuously by a triple record thermograph. On Dec. 18, 1948, the air temperature recorder ceased operating. Air temperatures after that date were obtained from the records of the weather station at the Raleigh-Durham airport. Rainfall was determined by a standard rain gauge. Theses in the Soils Department of Duke University were consulted for moisture content of soils in the forest. Ecological observations were obtained directly from two collectors in other areas who were supplied with blank chigger ecology data forms and lists of hosts from which they had sent chiggers.

Several persons made identifications of material other than chiggers. Miss Grace Gance, of the U. S. National Museum, identified the *Onychiurus* sp. and *Sinella curviseta*. Host identifications of the Pennsylvania Mammal Survey collections were made by Miss Caroline A. Heppenstall and Dr. J. K. Doult, Carnegie Museum, except for the later collections which were identified in the field by the collectors. Dr. F. S. Barkalow, Jr., State College, Raleigh, North Carolina, identified the hosts collected by Mr. Ray Allison in Wake County, North Carolina. Hosts trapped in Ohio and Kentucky by Mr. Woodrow Goodpaster, Cincinnati Museum of Natural History, were identified by the collector. Dr. G. W. Wharton, Duke University, identified certain mammal hosts from which he collected chiggers in Pennsylvania in July 1947. Some of the study skins made of representative mammal hosts collected at Duke University were identified to subspecies by Dr. David H. Johnson, U. S. National Museum. Mr. Kerwin Hyland, Duke University, identi-

fied the salamanders and *Culex quinquefasciatus* Say. Dr. J. R. Bailey, Duke University, identified the garter snakes and the worm snakes. All other identifications of Duke University host material were made to species only by the author.

Specimens of the new species described in this paper are deposited in the following collections: U. S. National Museum (USNM); Duke University (DU); Rocky Mountain Laboratory (RML); Carnegie Museum (CM); Kansas University (KU); South African Museum, Natal (Afr); South Australian Museum, Adelaide (Aus); and C. E. Farrell personal collection (CEF). The Duke University collection has been placed in the U. S. National Museum.

### Results

Hosts representing four classes of terrestrial vertebrates were collected in the Duke Forest area during the 28 consecutive months from September 1947 to December 1949 (table 1). Two species of amphibians, seven species of reptiles, 12 species of birds, and 20 species of mammals were included. These hosts were variously parasitized by more than 15 species of chiggers. No *Euschöngastia* was found on amphibians, reptiles, or birds. Seven species of mammals were parasitized by a total of five species of *Euschöngastia* (table 2). The mammalian hosts were *Blarina brevicauda*, *Sciurus c. carolinensis*, *Peromyscus leucopus*, *Peromyscus n. nuttalli*, *Pitymys p. pinetorum*, *Ondatra zibethica*, and *Sylvilagus floridanus mallurus*. The chiggers were *E. peromysci*, *E. rubra*, *E. blarinae*, *E. carolinensis*, and *E. setosa*.

Species of chiggers did not always occur singly in host collections or on individual hosts. In 37 collections of *Peromyscus leucopus* four species of *Euschöngastia* together with two new species of *Trombicula* and a new genus were found in various combinations (table 3). There were 13 of these combinations of species. *E. peromysci* was represented in all. The *E. peromysci*-*E. rubra* association was most frequent; it was common, also, on individual hosts where the white *E. peromysci* could be distinguished easily from the reddish *E. rubra*. In one collection of *Blarina brevicauda* both *E. blarinae* and the new genus were taken.

A number of chiggers other than *Euschöngastia* were removed from hosts collected during this study (table 4). These species represented three known genera—*Hannemania*, *Walchia*, and *Trombicula*—and one new genus. *Hannemania* sp. was found on

two species of amphibians; *Walchia* sp. on two species of mammals; and *Trombicula* on three species of reptiles, four species of birds, and ten species of mammals. Species of *Trombicula*

TABLE 1.—*Distribution of chiggers, all species, on vertebrate hosts collected in the Duke Forest area, September 1947 to December 1949*

Hosts	Total No. hosts	No. hosts infested	Hosts	Total No. hosts	No. hosts infested
<b>Amphibia</b>			<i>Richmondia cardinalis</i> (Linnaeus)	3	1
<i>Plethodon glutinosus</i> (Green)	2	2	<b>Mammalia</b>		
<i>Bufo</i> sp.	2	1	<i>Didelphis virginiana</i> Kerr	10	3
<b>Reptilia</b>			<i>Blarina brevicauda</i> (Say)	11	5
<i>Terrapene carolina</i> (Linnaeus)	50	29	<i>Eptesicus f. fuscus</i> (Beauvois)	1	0
<i>Sceloporus undulatus</i> (Latreille)	9	4	<i>Lasinus b. borealis</i> (Müller)	7	0
Skink	1	0	<i>Nycticeius humeralis</i> (Rafinesque)	1	0
<i>Carpophis a. amoenus</i> (Say)	4	0	<i>Procyon lotor</i> (Linnaeus)	7	1
<i>Thamnophis o. ordinatus</i> (Linnaeus)	2	0	<i>Mustela vison</i> Schreber	2	0
<i>Elaphe obsoleta</i> (Say)	1	0	<i>Urocyon cinereoargenteus</i> (Schreber)	1	0
<i>Agkistrodon mokasen</i> (Beauvois)	5	3	<i>Sciurus c. carolinensis</i> Gmelin	26	15
<b>Aves</b>			<i>Glaucomys v. rolans</i> (Linnaeus)	6	1
<i>Accipiter velox</i> (Wilson)	1	0	<i>Reithrodontomys humilis</i> (Audobon and Bachman)	4	0
<i>Philohela minor</i> (Gmelin)	1	0	<i>Peromyscus leucopus</i> (Rafinesque)	392	305
<i>Coccyzus americanus</i> (Linnaeus)	1	0	<i>Peromyscus n. nuttalli</i> (Harlan)	9	1
<i>Strix varia</i> (Barton)	1	0	<i>Sigmodon hispidus komareki</i> Gardner	6	1
<i>Centurus carolinus</i> (Linnaeus)	1	0	<i>Microtus p. pennsylvanicus</i> (Ord)	14	5
<i>Sphyrapicus varius</i> (Linnaeus)	2	0	<i>Pitymys p. pinetorum</i> (LeConte)	3	2
<i>Dryobates villosus</i> (Linnaeus)	1	1	<i>Ondatra zibethica</i> (Linnaeus)	11	4
<i>Nannus hiemalis</i> (Vieillot)	1	0	<i>Mus musculus</i> Linnaeus	3	0
<i>Thryothorus ludovicianus</i> (Latham)	2	1	<i>Sylvilagus floridanus</i> (Linnaeus)	18	12
<i>Turdus migratorius</i> Linnaeus	1	1	<i>Sylvilagus p. palustris</i> (Bachman)	1	1
<i>Vireo florifrons</i> Vieillot	1	0			

included *T. alfreddugèsi*, *Trombicula* near *akamushi*, *T. splendens*, *T. whartoni*, *Trombicula* spp., and two new species (*T. carterae* Brennan and Wharton, 1950, and *T. farrelli* Brennan and Wharton, 1950). The new genus was found on two species of mammals.

Collections of unattached chiggers and postlarval stages of trombiculids during the 30 months from October 1947 to March 1950. in the Duke Forest area are listed in table 5. There were

146 samples, representing 24 ecological niches, collected and placed on Berlese funnels. Except where noted, all collections were from upland hardwoods communities. Most of the samples

TABLE 2.—*Distribution of Euschöngastia species on mammalian hosts in the Duke Forest area, September 1947 to December 1949*

Hosts	Total collections	Number of positive collections				
		<i>E. peromysci</i>	<i>E. rubra</i>	<i>E. blarinae</i>	<i>E. carolinensis</i>	<i>E. setosa</i>
<i>Blarina brevicauda</i>	11	0	0	5	0	0
<i>Sciurus c. carolinensis</i>	17	1	0	0	0	0
<i>Peromyscus leucopus</i>	91	71	31	0	1	10
<i>Peromyscus n. nuttalli</i>	8	1	0	0	0	0
<i>Pitymys p. pinetorum</i>	3	1	0	0	1	0
<i>Onychomys leucogaster</i>	9	2	0	0	0	0
<i>Sylvilagus floridanus mallurus</i>	17	0	1	0	0	1

(A collection consisted of all host specimens of one species collected in one locality on one date)

were taken during the months from November to April. During the May–October period, five samples from surface soil of fields and thickets yielded two positive for *T. alfreddugèsi* adults; one leaf accumulation from a hollow log was positive for *E. peromysci*; and the one collection of a *Sylvilagus floridanus mallurus* nest from a thicket was positive for engorged *T. alfreddugèsi*.

TABLE 3.—*Combinations of various species of chiggers in 91 collections of Peromyscus leucopus in the Duke Forest area, September 1947 to December 1949*

<i>Euschöngastia peromysci</i>	<i>E. rubra</i>	<i>E. setosa</i>	<i>E. carolinensis</i>	<i>Trombicula farrelli</i>	<i>T. carterae</i>	New genus	Frequency
x	x						19
x	x	x					3
x						x	3
x		x					2
x	x			x			2
x		x			x		1
x		x		x			1
x	x				x		1
x	x	x			x		1
x	x	x		x			1
x	x				x	x	1
x					x	x	1
x			x				1

During this same period, two samples from surface litter and debris, two of surface soil, one of humus from logs, one from under loose bark of a standing dead hardwood stub, and one

deserted and two occupied *Peromyscus n. nuttalli* nests were negative.

In the collections from soil, 7 to 30 cm. depth, the soil samples were taken from the side of a trench dug in the forest floor. In several instances an area was sampled more than once. The 16 samples of surface soil from fields and thickets were taken from four areas. Surface debris was sampled three times near the base of a standing stub (pl. 2) with one positive sample. Two samples each from two sites resulted in four of the positive

TABLE 4.—Distribution of chiggers other than *Euschöngastia* on hosts in the Duke Forest Area, September 1947 to December 1949

Hosts	Species of chiggers									
	<i>Hannemania</i> sp.	<i>Walchia</i> sp.	<i>Trombicula</i> <i>alfreddugesi</i>	<i>T.</i> <i>splendens</i>	<i>T.</i> <i>whartoni</i>	<i>T.</i> near <i>akamushi</i>	<i>T.</i> <i>cartracae</i>	<i>T.</i> <i>farrelli</i>	<i>Trombicula</i> sp.	New genus
<i>Bufo</i> sp.....	x									
<i>Plethodon glutinosus</i> .....	x									
<i>Terrapene carolina</i> .....			x							
<i>Sceloporus undulatus</i> .....			x							
<i>Agkistrodon mokasen</i> .....			x							
<i>Dryobates villosus</i> .....			x							
<i>Thryothorus ludovicianus</i> .....			x	x						
<i>Turdus migratorius</i> .....			x							
<i>Richmondia cardinalis</i> .....			x							
<i>Didelphis virginiana</i> .....			x						x	
<i>Blarina brevicauda</i> .....										x
<i>Procyon lotor</i> .....		x								
<i>Sciurus c. carolinensis</i> .....		x		x	x				x	
<i>Glaucomys v. volans</i> .....									x	
<i>Peromyscus leucopus</i> .....			x			x	x	x		x
<i>Sigmodon hispidus komareki</i> .....					x					
<i>Microtus p. pennsylvanicus</i> .....					x					
<i>Ondatra zibethica</i> .....					x					
<i>Sylvilagus floridanus mollurus</i> .....			x		x					
<i>Sylvilagus p. palustris</i> .....					x					

samples from surface soil in hardwoods. One of the sites was the type locality of *E. carolinensis* (pl. 2). Two sites (pl. 2, upper right and lower left) with three samples each gave six of the positive samples from under old stumps and from decayed-out root systems; another site in two samples gave one positive and the only negative for this niche. Fifteen samples from one stub (pl. 2) resulted in nine of the positive samples taken under loose bark of standing dead stubs and trees. Another stub gave one



Upland hardwood forest, Compartment 76, Durham Division, Duke Forest, N. C.,  
habitat of species of *Euschöngastia* and their common hosts.

## PLATE 2

Upper left: Type locality of *Euschöngastia carolinensis*, Compartment 77, Durham Division, Duke Forest, N. C. The chiggers were recovered from soil at the base of the shrub.

Upper right: Type locality of *Euschöngastia rubra*, Compartment 76, Durham Division, Duke Forest, N. C. The small, curved, decayed stump (at the left, upper edge of the large shadow) was removed. The chiggers were recovered from the debris under the stump.

Lower left: Cavities left by decomposition of a root system, Compartment 76, Durham Division, Duke Forest, N. C. For the photograph the stump was lifted from its position in the ground. A few *Trombicula farrelli*, *Euschöngastia rubra*, and *E. setosa* and many *E. peromysci* were recovered from the debris in the cavities.

Lower right: Standing dead stub, Compartment 8, New Hope Creek Division, Duke Forest, N. C. Identified from wood and bark samples as "one of the red oaks" by Dr. E. S. Harrar, Department of Forestry, Duke University. *Trombicula splendens* adults and *Trombicula* sp. adults, nymphs, and larvae were collected from the debris under the loose bark of the stub. One undetermined adult trombiculid was collected from the debris at the base. *Peromyscus leucopus* with *Euschöngastia peromysci* and *E. rubra* in its ears was trapped at the base of the stub. No unattached *Euschöngastia* was taken at this site.





EXPLANATION ON FACING PAGE

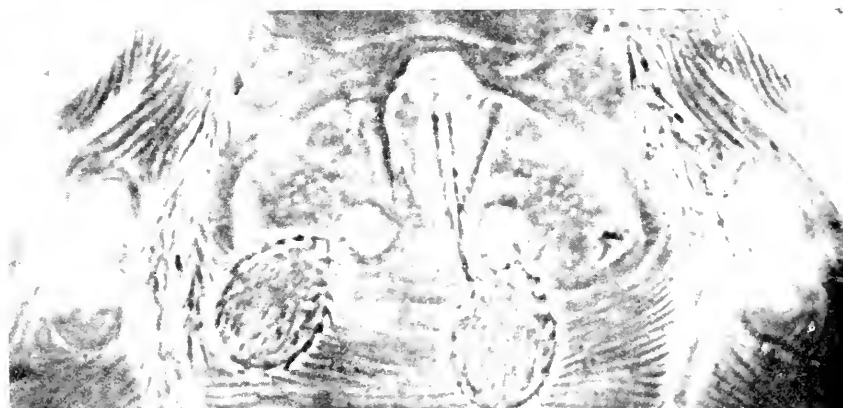
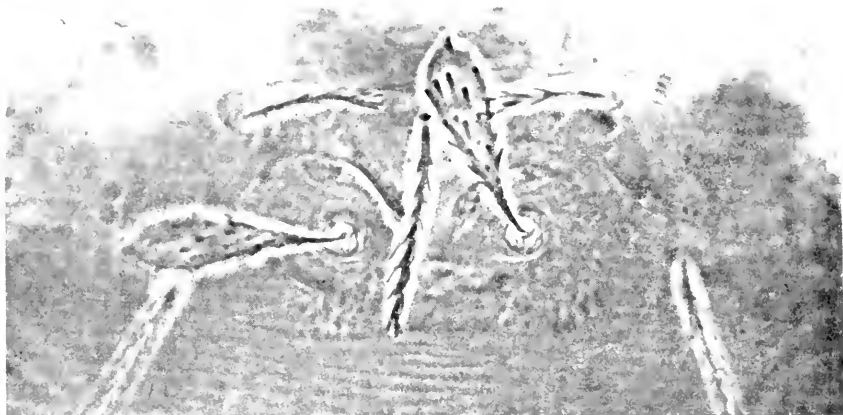
PLATE 2

Upper: Andropogon field, Compartment 16, New Hope Creek Division, Duke Forest, N. C. The field is small and partly surrounded by upland hardwoods. *Peromyscus leucopus*, infested with species of *Euschöngastia*, was trapped in the surrounding hardwoods but was never taken in the field. *Microtus*, *Sigmodon*, and *Reithrodontomys* were trapped in the field but never in the surrounding hardwoods. *Microtus* and *Sigmodon* were parasitized by *Trombicula zhartoni* but never by *Euschöngastia*. *Trombicula zhartoni* was never collected from *Peromyscus leucopus*.

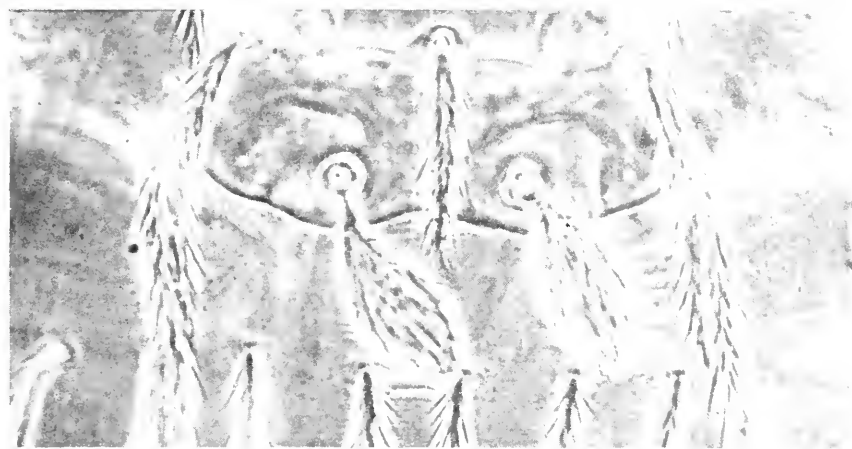
Lower: Detached *Euschöngastia peromysci* on the ear of *Peromyscus leucopus*, the deer mouse,  $\times 5.5$ .



EXPLANATION ON FACING PAGE



Photomicrographs of scuta, 1975. Upper: *T. (St.) laticornis* (1000 $\times$ ).  
Middle: *T. (St.) laticornis* (1000 $\times$ ). Lower: *T. (St.) laticornis* (1000 $\times$ ).



Photomicrographs of scuta,  $\times 975$ . Upper, *Leptocryptus (Leptocryptus) melleus*; Middle, *Leptocryptus (Leptocryptus) melleus*; Lower, *Leptocryptus (Leptocryptus) melleus*.



positive in six samples. The hollow base of one tree was sampled twice with one positive.

TABLE 5.—*Distribution of unattached chiggers and postlarval stages of trombiculids collected from ecological niches in the Duke Forest area, October 1947 to March 1950*

Niches sampled	Total samples	Total positive samples	Chiggers and post-larval trombiculids	Positive samples
Surface soil, fields and thickets	16	6	<i>T. olfreddugèsi</i> nymphs and adults.	6
Surface litter and debris	7	2	<i>E. peromysci</i>	1
			Trombiculid adult	1
Surface soil and humus	27	6	<i>E. blarinae</i>	1
			<i>E. peromysci</i>	1
			<i>E. rubra</i>	2
			<i>E. carolinensis</i>	2
			<i>T. whartoni</i>	1
Soil, 5 to 15 cm. depth	1	1	<i>E. peromysci</i>	1
Soil, 19 to 30 cm. depth	1	1	<i>E. rubra</i>	1
Soil and debris under logs	1	0		
Mammal runways and burrows	6	4	<i>E. blarinae</i>	1
			<i>E. peromysci</i>	3
			Trombiculid adult	1
			New genus	1
Hollow base of tree	5	3	<i>E. rubra</i>	1
			<i>Walchia</i> sp.	1
			Trombiculid nymph	1
Humus from logs and stumps	9	2	<i>E. peromysci</i>	2
Under old stumps and decayed-out root systems	13	12	<i>E. blarinae</i>	2
			<i>E. carolinensis</i>	2
			<i>E. peromysci</i>	10
			<i>E. rubra</i> (one engorged)	6
			<i>E. setosa</i>	1
			<i>T. farrelli</i>	1
			Trombiculid adults	3
Under bark of fallen trees	4	0		
Humus from decaying branch against stub	1	1	<i>Trombicula</i> sp.	1
Under loose bark of standing dead hardwood trees and stubs	35	12	<i>T. farrelli</i>	1
			<i>T. splendens</i> adults	3
			<i>Trombicula</i> sp.	6
			<i>Trombicula</i> sp. nymphs and adults	9
Under loose bark of pine stub	1	0		
Debris scraped from standing dead tree	1	0		
Debris from crotch of oak tree	2	0		
Cavity in living tree	3	1	<i>Trombicula</i> sp.	1
			<i>Walchia</i> sp.	1
Leaf accumulations in hollow logs	4	3	<i>E. peromysci</i>	2
			Trombiculid nymph	1
<i>Peromyscus n. nuttalli</i> nest, occupied	2	0		
<i>Peromyscus n. nuttalli</i> nest, deserted	3	1	Trombiculid adults	1
<i>Sciurus c. carolinensis</i> nest, occupied	1	1	<i>T. whartoni</i> (engorged)	1
<i>Sciurus c. carolinensis</i> nest, deserted	1	0		
<i>Sylvilagus floridanus mollurus</i> nest, about one day vacant, thicket	1	1	<i>T. olfreddugèsi</i> (engorged)	1
Ant nest in pine stump	1	0		

All five species of *Euschöngastia* that were collected from hosts in the Duke Forest area were recovered also in the unattached and unengorged condition from one or more of these samples. *E. peromysci* occurred in twenty samples; *E. rubra*, in ten; *E. blarinae*, in four; *E. carolinensis*, in four; and *E. setosa*, in one. The number of chiggers recovered from a positive sample usually was small—from one to three specimens. However, a few samples collected under decayed stumps produced a great many *E. peromysci*. Other species were never numerous. Most productive samples were taken under old stumps and in holes left by decayed roots (pl. 2), and in the runways of mammals. No collection of *Euschöngastia* was made from standing living or dead trees; none was made from fallen trees or branches unless decay was well advanced and a hollow formed; and none was made from fields (pl. 3, upper). All positive samples were from forest soil or from sources in intimate contact with it.

Three collections of white trombiculid adults, a total of seven specimens, were made from material gathered under the removable stump at the type locality of *E. rubra* (pl. 2, upper right). These probably were *Euschöngastia*, but confirmation of this could not be made.

## Phylum ARTHROPODA

### Subphylum CHELICERATA

### Class ARACHNIDA

### Order ACARINA

### Suborder TROMBIDIFORMES

### Group PROSTIGMATA

### Family TROMBICULIDAE Ewing, 1944

### Subfamily Trombiculinae Ewing, 1929

### Genus *Euschöngastia* Ewing, 1938

#### FIGURE 8,b

*Schöngastia* Oudemans [part], 1910, pp. 86, 87 (fide Sig Thor and Willmann, 1947, p. 297).

*Neoschöngastia* Ewing [part], 1929d, pp. 22, 28, 188.

*Euschöngastia* Ewing, 1938, p. 293.

*Euschöngastia*, Vitzthum, 1942, p. 829 (treated as a subgenus of *Schöngastia* Oudemans, 1910).

*Ascöschöngastia* Ewing [part], 1946b, p. 71.

*Boshellia* Ewing, 1950, pp. 294–295, 296.



TYPE OF GENUS: *Euschöngastia americana* Ewing, 1938 (= *Euschöngastia sciuricola* (Ewing, 1925)). Monotypic.

#### MORPHOLOGY

All chiggers have the same basic external form. The size is small, rarely more than a millimeter in length even when heavily engorged and greatly flattened in preservation on slides. (In this paper the dimensions of length and width are given in microns.) Colors range through white, cream, yellow, and various intensities or shades of red. The body is oval or ovoid in shape, more or less inflated, in one unit without apparent segments. Attached to the anteroventral portion are two pairs of jointed appendages, the pedipalps and the chelicerae, which constitute the mouthparts or gnathosoma. From the base of each palp a flaplike process, the galea, curves forward and upward around the anterolateral surface of each chelicera. Immediately posterior to the gnathosoma on the lateral portions of the ventral surface are three pairs of jointed walking legs terminating in two lateral claws and a median empodium. On the anterodorsal surface, slightly posterior to the gnathosoma, is a sclerotized plate, the scutum. One or two pairs of simple eyes, usually, are located lateral to the scutum. The body surface is covered with cuticular striae which generally encircle the scutum and the basal segments of the legs. Posteriorly the striae tend to run at right angles to the longitudinal body axis. The anus is situated on the ventral surface considerably anterior to the apparent posterior end of the mite. The mouth is not obvious but is located at the bases of the chelicerae and the palps. The body is clothed with transverse rows of setae. These setae are usually more or less plumed by setules, tapered projections from the central shaft. The galeae, the segments of the palps, and the segments of the legs bear setae which are nude or plumed with setules. Nude striated setae may be found on the final segment of the palps and on the three distal segments of the walking legs. The scutum carries setae, usually with setules, which vary in number in various groups of chiggers. Two specialized setae, the sensillae, are always found on the scutum. The sensillae arise from pits, the pseudostigmata. In some groups of chiggers true stigmata are located near the base of the gnathosoma. Indented in the posterior edge of the first or proximal segment of the first pair of walking legs is a pit, the urstigmen. The scutum, segments of the palps, the basal segment of the chelicerae, and the segments

of the legs may be decorated with punctations, or punctae. Punctae are usually described as pits in the cuticle.

Within the basic chigger pattern the genus *Euschöngastia*, as it is now known in North America, has its own basic form (figs. 1-3). The size varies but all specimens have been less than a millimeter in length. Measurements are made from specimens preserved on slides. The length is the over-all measurement from the posterior edge of the body to the most anterior extension of the body or the gnathosoma. The width is the widest dimension. Shape, unless otherwise indicated, is taken from specimens preserved on slides. Color is recorded from living specimens.

The gnathosoma is compact and somewhat cone-shaped. The palps have five segments. The basal segments of the two palps, the coxae, are fused to form a single ventromedian plate. It is usually marked with punctae. Also fused with it are the trochanters, although the line of fusion often can be determined. At the anterolateral corners of the fused coxae, posterior to the union with the trochanters, is a pair of curved setae with setules along the outer curvature. The palpal coxa is often referred to as palp 1 in descriptions and drawings. The palpal femur, palp 2, swells forward and upward. It is rounded laterally on the dorsal aspect but usually is somewhat excavated on the posterolateral surface from the ventral aspect. It bears on its dorsal surface, posterolaterally, a single seta which curves anteriorly. The seta is covered with setules except that the concave curvature adjacent to the palp tends to be nude. The palpal genu, palp 3, is a short truncate cone smoothly continuing the taper of the femur. On its dorsal surface is a single forward-curving seta which usually bears setules on the convex curvature. In two species normally and in a third occasionally, the seta is nude. The palpal tibia, palp 4, continues the taper of the genu and terminates in the palpal claw. It bears three setae. The first tibial seta is a forward-curving dorsal which usually has setules on the outer curvature. The second is lateral. It varies in different species and is much used as a taxonomic character. It may have numerous setules on its outer curvature and be described as pectinate; it may bear only one or more setules, which can be counted easily, and be described as forked or branched; or it may be entirely nude. The third tibial seta is ventrolaterally placed. It usually projects laterally, and in all species except one has setules over the longitudinal dorsal half of the shaft. The palpal claw is divided into two to seven prongs in different species. When the

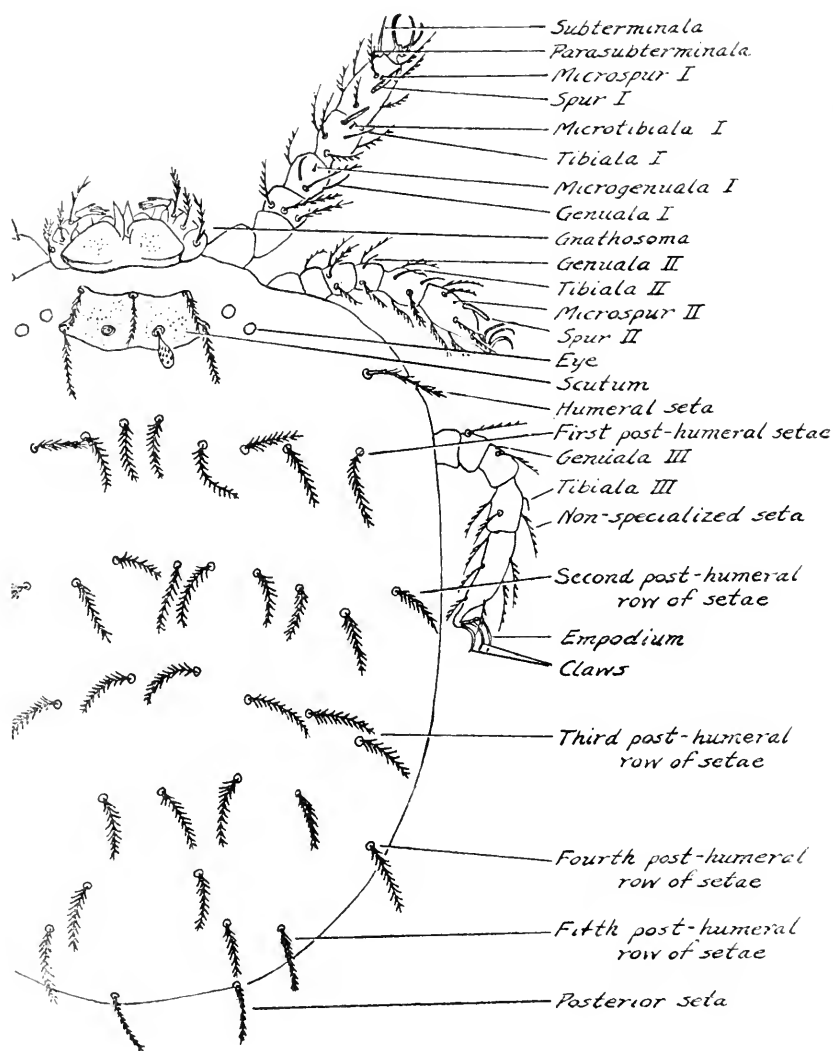
length of the palpal claw is given in descriptions, the total length, including the basal portion imbedded in the tibia, is used. The tarsus, palp 5, is a short, thumblike segment attached ventrally to the tibia at the base of the palpal claw and opposable to it. In most species the tibia bears seven feathered setae—a large dorsal, three near the apex, and three basal and ventral. Ventrally, near the articulation with the tibia, the tarsus bears a striated seta, or spur.

On each galea is a seta which in different species varies in form. It may be nude, forked, branched, or pectinate; or the setules may arise on opposite edges of the shaft. The galeal seta is an important taxonomic character.

A chelicera is composed of two segments. The base is heavy, usually angulate laterally, and may have punctae on its dorsal surface. The distal segment is bladelike and curved. It bears near the apex a dorsolateral tooth, which sometimes cannot be found, and a larger ventrolateral tooth.

The legs are composed of seven segments. By convention for brevity the three pairs of legs are numbered with Roman numerals from anterior to posterior—I, II, and III. The segments of the legs are numbered with Arabic numerals. However, the two sets of numerals are not used together except in designating drawings. The coxa, or basal segment articulating with the body, is segment 1. The first freely movable segment, the trochanter, is segment 2. The femur is divided into two parts. The more proximal part is the basifemur, segment 3; and the more distal part is the telofemur, segment 4. The genu is segment 5. The tibia is segment 6. The most distal, terminal segment is number 7, the tarsus. On the leg segments are various specialized striated setae and nonspecialized feathered setae. Some are constant throughout the genus, others vary. All segments have nonspecialized setae with setules. On all segments except the coxae and the trochanters these setae tend to lie parallel with the leg. Those on the coxae extend posteriorly. Those on the trochanters tend to curve ventrally and posteriorly around the segment. All are nude on the side adjacent to the leg or the body; the side opposite to the leg or body bears setules of slightly varying length and form in different species. The segments may be marked with punctae.

On the coxa of leg I is a nonspecialized seta attached near the anterior margin of the urstigmen. The trochanter bears a nonspecialized seta attached proximally at the anterodorsal margin, curving posteriorly beneath the segment. The basifemur has a

FIGURE 1.—Dorsal view of *Euscöngastia oregonensis*.

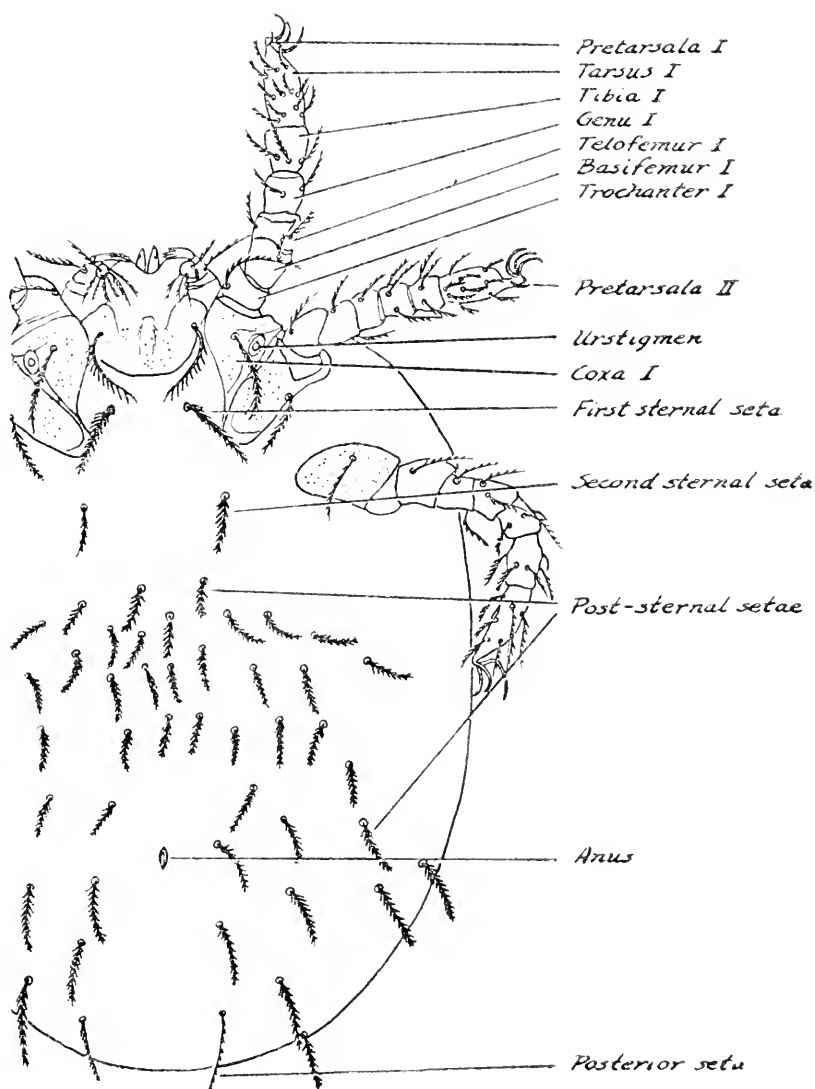


FIGURE 2.—Ventral view of *Euschöngastia oregonensis*.

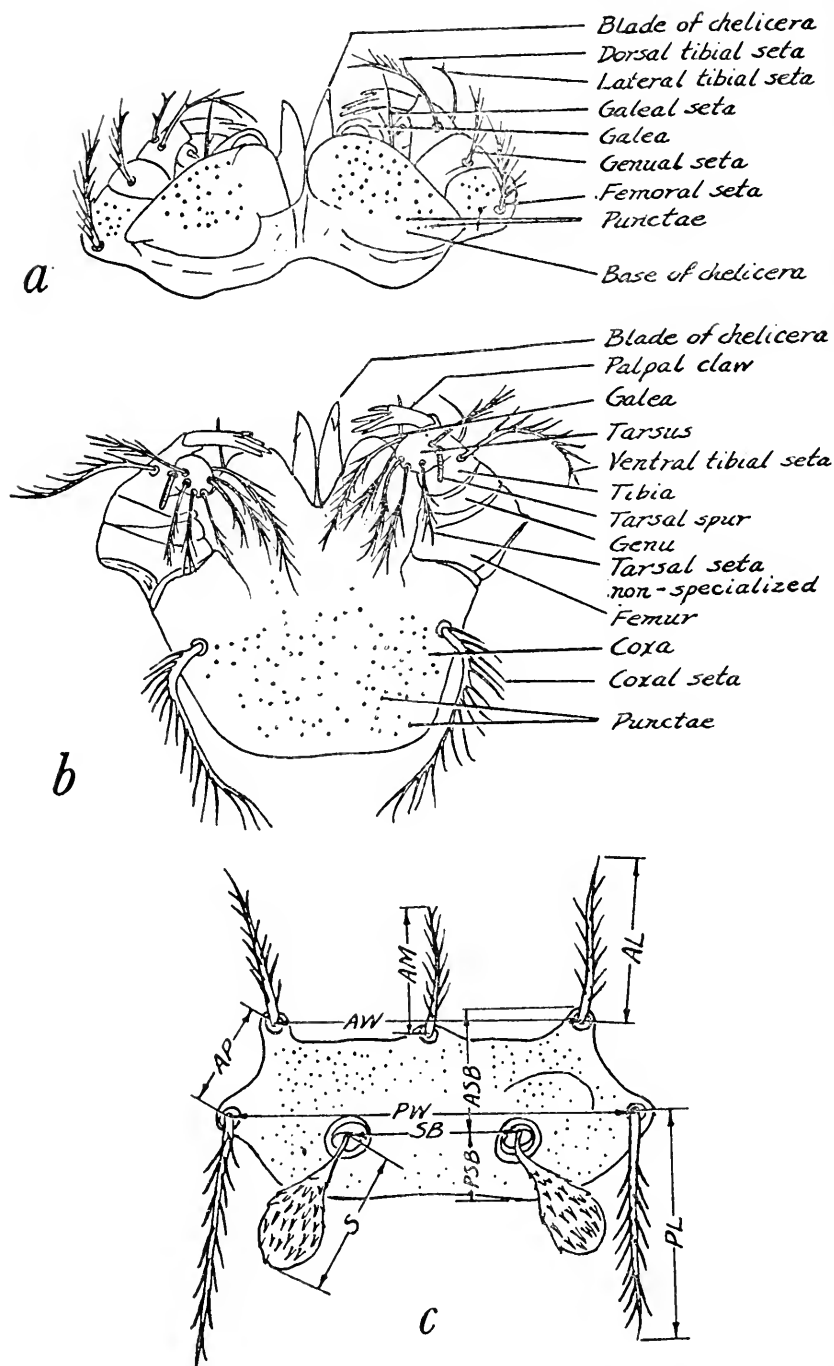


FIGURE 3.—*a*, Dorsal view of gnathosoma of *Euschöngastia oregonensis*; *b*, ventral view of same; *c*, scutum of *E. oregonensis*, with measurements of standard data (explanation of abbreviations on page 123).

single nonspecialized seta attached distally at the posteroventral margin. The telofemur bears five nonspecialized setae, three proximally in a transverse row across the dorsal surface and two on the ventral surface. The genu bears four nonspecialized setae about evenly spaced around it on the proximal half. Usually it has, also, two rather long, pointed, striated, specialized setae—the genualae. One of these is dorsal and anterior; the other is posterior. A small, pointed, striated microgenuala is located distally on the dorsal surface. The tibia usually has seven nonspecialized setae, one proximally on the dorsal surface, one at the middle of the anterior dorsal margin, one on the posterior dorsal margin, and four on the proximal half of the ventral surface. The tibia bears two striated, specialized tibialae. The tibiala on the distal, dorsal margin is somewhat blunt; the one proximal to it is pointed. Just posterior to the distal tibiala is a small, pointed, striated microtibiala. The tarsus bears about 22 nonspecialized setae. Near the middle of its dorsal surface is a strong, blunt, striated seta, the spur. Slightly distal, usually, to the spur is a small pointed striated seta, the microspur. Distally and anteriorly, on an eminence of the tarsus in all but two species, are two striated setae. The larger and more distal of the two is the subterminala; the smaller, slightly more proximal, is the parasubterminala. Beyond the eminence of the tibia, the segment tapers quickly to the rather slender pretarsus, at the end of which are two lateral, curved claws with a thinner curved empodium between them. On the posterior edge of the pretarsus just proximal to the claws is a pointed, striated seta, the pretarsala.

The coxa of leg II is contiguous with coxa I. It has a long, nonspecialized seta attached at its posterior margin. A long, nonspecialized seta is fastened proximally on the anterodorsal margin of the trochanter. The basifemur bears two nonspecialized setae, one anterior and one posterior. The telofemur has four nonspecialized setae, three proximally in a transverse row across the dorsal surface and one on the anterior surface. The genu has three nonspecialized setae spaced around the proximal half. On its middorsal surface, usually, is a pointed, striated seta, the genuala. The tibia bears six nonspecialized setae—one anterior and one posterior on the dorsal surface, two on the ventral surface, and one each on the anterior and posterior surfaces. Two striated setae, the tibialae, are located on the dorsal surface in tandem. The proximal tibiala is more pointed than the distal.

The tarsus bears about 16 nonspecialized setae. On its dorsal surface is a long, blunt, striated spur with a microspur just proximal to it. On the posterior edge of the pretarsus is the pointed, striated pretarsala. Two claws and an empodium similar to those on leg I are attached to the end of the pretarsus.

The coxa in leg III is separated from coxa II, the distance increasing with engorgement. A single seta, usually, is attached near its anterior margin. The form of coxa III and the attachment of its seta vary slightly in different species. The trochanter has a nonspecialized seta attached proximally at the anterodorsal margin. The basifemur has two nonspecialized setae—a larger dorsal and a smaller ventral. On the proximal dorsal surface of the telofemur is a transverse row of three nonspecialized setae. The genu has three nonspecialized setae spaced around it. Usually there is a pointed, striated genuala on its dorsal surface. The tibia has six nonspecialized setae spaced around it. In about half the species a pointed, striated tibiala is found on the proximal half of its dorsal surface. The tarsus bears about 15 nonspecialized setae. One species has a long, nude, whiplike seta, a mastitarsala. The tarsus terminates in a pair of claws and a median empodium somewhat longer than those on legs I and II.

The scutum varies in size and shape among the species of *Euschöngastia*. Ornamentation varies also, but ridges and punctae are usual. In some species the striated cuticle appears to have encroached upon or to have folded over the posterior or lateral margins. There are always five setae in addition to the sensillae. Near the middle of the anterior margin is the anterior median seta. At the corners between the anterior and lateral margins are the anterior lateral setae. At the angles between the lateral margins and the posterior margin are the posterior lateral setae. These setae are clothed with setules. The five scutal setae generally resemble the dorsal setae. All *Euschöngastia* have expanded sensillae. The sensillae arise from the pseudostigmata, which are rather large and deep pits in the scutum. The slender, basal pedicel may gradually become larger in diameter and blend into the head of the sensilla; or it may increase very little and be distinctly set off from the enlarged head. The enlarged head is clothed with setules. In many species the posterior surface of the sensilla bears fewer and heavier setules than the anterior surface. For the determination of anterior and posterior surfaces, the sensilla is considered to be standing erect on the scutum.

The standard data of the scutum (fig. 3,c), which are included in descriptions of species, consist of measurements in microns



of several dimensions of the scutum and the lengths of the setae. All measurements involving setae or sensillae start at the mid-point of the basal attachment. Often, the width of the sensilla is given and is indicated by an "x" following the length.

Following are the explanations of the abbreviations used in connection with these dimensions:

- AW: Width of the scutum between the bases of the anterior lateral setae.
- PW: Width between the bases of the posterior lateral setae.
- AP: Distance between the bases of an anterior lateral seta and a posterior lateral seta on one side.
- SB: Distance between the sensillary bases, the points of attachment of the sensillae.
- ASB: Distance from the anterior margin to the bases of the sensillae. When the anterior setae are set on anterior expansions of the scutum, these expansions are included in ASB. For the purpose of determining standard data, the anterior margin is considered to lie at a straight, transverse line touching the most anterior points of these expansions.
- PSB: Distance from the bases of the sensillae to the posterior margin, which is considered to lie at a straight, transverse line touching the most posterior expansions of the scutum.
- AL: Length of an anterior lateral seta.
- AM: Length of the anterior median seta.
- PL: Length of a posterior lateral seta.
- S: Length of a sensilla.

Two pairs of simple eyes usually are present. Two species have ocular plates. Two species have one pair of obscure eyes.

Dorsal body setae are arranged in transverse rows which are usually distinct, especially in partly engorged specimens. A pair of humeral setae, one seta on each side of the body, is set off anterolaterally in engorged specimens; but in unengorged specimens these setae may lie at the ends of the first transverse row. By convention in descriptions of chiggers the dorsal setal formula consists of listing serially the number of setae in each of the transverse rows, beginning with the humeral setae and proceeding posteriorly. Frequently there are setae on the lateral edges of the body not easily assignable to a row. These are inserted in the formula where they occur and are usually recognizable by being smaller numbers between larger numbers. In a list of several dorsal formulae these so-called lateral setae will not be indicated in all specimens. The dorsal setae usually resemble the scutal setae. The form of the posterior setae may differ from that of the anterior setae. Particularly in unengorged chiggers, the setae project posteriorly somewhat parallel to the body. They tend to be nude on the side adjacent to the body.

On the ventral surface of the body a pair of feathered setae is found between coxae I. These are the first or anterior sternal setae. The second or posterior sternal setae are located between coxae III. With one exception there is one pair of second sternals; in one species there are four second sternals. All sternals curve posteriorly and have relatively long and slender setules on the outer curvature. Posterior to coxae III the number of ventral setae varies with species and specimen. The arrangement into rows is indistinct in most species, and ordinarily no effort is made to count these setae by rows. A ventral setal formula consists of enumerating the first sternals and the second sternals plus the total number of setae posterior to the sternals. However, since the number of sternals is so constant in a species that deviations are considered anomalous, ventral formulae usually are not given in the descriptions. The number of sternals common to the species and the range of variation of the setae posterior to the sternals is given. All poststernal setae may be similar to the dorsals; or there may be a rather sharp change in form about the level of the anus. In the latter case the setae posterior to the anus have the form of the dorsals; and those anterior to the anus have a different form. Ventral setae lie somewhat parallel to the body and tend to be nude on the side adjacent to the body.

In the descriptions of the species and groups of species a general description will not be repeated. Attention will be concentrated on those features which at this time appear to be important in making combinations of species or in differentiating them. In plates 9-21, the appendages and their segments are referred to by numbers. The order of the appendages and their parts are the same as has been followed in this general description of the morphology of the genus. All measurements are in microns.

#### DIAGNOSIS

The diagnosis of *Euschöngastia* by Fuller (1952), after emendation, has been adopted for this paper: All legs with seven segments; true stigmata and tracheae absent; empodium clawlike; no caudal plate; eyes usually present; coxa II with a single seta; scutum with five setae in addition to sensillae; scutum not submerged beneath the cuticular striae; sensillae expanded distally; chelicerae bladelike, each with a single dorsal tooth; palpal claw with two to seven prongs.

A note should be added to this diagnosis. In the closely related genus *Neoschöngastia* the scutum is submerged beneath the cuticular striae. In a few species of *Euschöngastia* cuticular striae

appear to have folded over the posterior portion of the scutum, occasionally over the lateral margins.

### Key to species of *Euschöngastia* of North America

1. Tibiala III present ..... 2  
No tibiala III ..... 14
2. No subterminala or parasubterminala I ("*lacerta*" group) ..... 3  
Subterminala and parasubterminala I present ..... 4
3. One genuala I; microspur I distal to spur ..... 1. *E. lacerta* Brennan  
Two genualae I; microspur I proximal to spur.  
2. *E. bigenuala*, new species
4. Palpal claw with two prongs; a mastitarsala III present.  
3. *E. nuñezi* (Hoffmann)  
Palpal claw with more than two prongs; no mastitarsala III ..... 5
5. Palpal claw with more than three prongs; sensillae elongate-clavate,  
joining with pedicels in gradual taper ..... 6  
Palpal claw with three prongs; sensillae capitate or subcapitate, heads  
more abruptly distinct from pedicels ..... 9
6. Three genualae I ..... 4. *E. trigenuala*, new species  
Two genualae I ..... 7
7. One pair of eyes, or corneas indistinct or lacking; galeal seta nude.  
5. *E. pipistrelli* Brennan  
Two pairs of eyes, corneas distinct; galeal seta branched ..... 8
8. Lateral seta on palpal tibia branched ..... 6. *E. oregonensis* (Ewing)  
Lateral seta on palpal tibia nude ..... 7. *E. samboni* (Radford)
9. Scutum with only two crescentic ridges, one anterior to each pseudo-  
stigma ..... 10  
Scutum with three joined ridges, one anterior to each pseudostigma and  
a third extending from the apexes of these anteriorly around the  
anterior median seta ("*rubra*" group) ..... 11
10. Ventral setal formula begins 2-2 ..... 8. *E. peromysci* (Ewing)  
Ventral setal formula begins 2-4 ..... 9. *E. cordiremus* Brennan
11. Lateral seta on palpal tibia pectinate; anterior and posterior dorsal  
setae similar ..... 12  
Lateral seta on palpal tibia usually nude; anterior dorsal setae with  
numerous long setules, posterior dorsal setae with fewer, scalelike  
setules (*E. diversa*, new species) ..... 13
12. Scutum smaller, PW less than 67 microns; range southern.  
10. *E. rubra*, new species  
Scutum larger, PW about 77 microns; range northern.  
11. *E. magna*, new species
13. Palpal claw shorter, branching on proximal half, accessory prongs inter-  
rupting contour of claw ..... 12a. *E. diversa diversa*, new subspecies  
Palpal claw longer, branching on distal half, accessory prongs lying close.  
12b. *E. diversa acuta*, new subspecies
14. Palpal claw with three prongs ..... 15  
Palpal claw with more than three prongs ..... 19
15. Two setae on coxa III ..... 13. *E. guntheri* (Radford)  
One seta on coxa III ..... 16

16. Nonspecialized setae of leg I with numerous, fine, curved setules.  
Scutum with strong ridges anterior to each pseudostigma, pseudostigmata deeply recessed .....17  
Nonspecialized setae of leg I with rather few, heavy, straight setules.  
Scutum plain, or with ridges not strongly indicated, no deeply depressed areas ("*luteodema*" group) .....18
17. Lateral seta on palpal tibia with one or two thin setules (or nude, Brennan, 1948) .....14. *E. criceticola* Brennan  
Lateral seta on palpal tibia strongly pectinate.15. *E. californica* (Ewing)
18. No genuala II or III .....16. *E. luteodema* Brennan  
Genuala II and III present .....17. *E. marmotae*, new species
19. AL's and PL's long, about 70-80 microns, and about the same length; scutum roughly rectangular .....18. *E. hamiltoni* Brennan  
AL's much shorter than PL's; scutum tends to be pointed at posterolateral corners ("*blarinae*" group) .....20
20. Posterior dorsal setae leaflike, broad and thin with small setules on surface away from body .....21  
Posterior dorsal setae with round shaft with setules grouped around it 22
21. About final three rows of dorsal setae flattened; range southern.  
20. *E. carolinensis*, new species  
Flattened setae confined mostly to final dorsal row; range northern.  
21. *E. ohicensis*, new species
22. Scutum and leg segments distal to coxae with punctae .....23  
Scutum and leg segments distal to coxae without punctae .....24
23. Cheliceral base with punctae; galeal setae strong with setules along opposite edges .....22. *E. crateris*, new species  
Cheliceral base without punctae; galeal setae branched.  
19. *E. blarinae* (Ewing)
24. Head of sensilla cordiform; cheliceral base without punctae; range western .....24. *E. sciuricola* (Ewing)  
Head of sensilla ovoid; cheliceral base with fine punctae; range eastern.  
23. *E. setosa* (Ewing)

### The "*lacerta*" group

The "*lacerta*" group consists of *E. lacerta* and *E. bigenuala*. The group is unique in the genus. The mites are very small. Body striae are fine. The anus is farther posterior than usual. Punctae on the cheliceral base are confined to the posterior portion. The number of body setae is reduced and the setae are small with fine setules. The nonspecialized setae of palps and legs are small with relatively few, fine setules. Tibia I has eight nonspecialized setae. The tarsi have fewer nonspecialized setae than usual, tarsus I having about 19 or 20, and tarsi II and III about 13 or 14. Subterminala and parasubterminala I are lacking. There are no genualae II and III. The general shape and character of the scuta of the two species in the group are similar. The pseudostigmata are set in the bases of short ridges which bound them anteromedially.

1. *Euschöngastia lacerta* Brennan

FIGURE 4,a; PLATES 6, 9

*E. lacerta* Brennan, 1948, pp. 465, 467-468, 477, figs. 2A-D, 9.

DESCRIPTION: With the characters of the group.

Size: Length, 330 to 350; width, 170 to 235.

Shape: Oval or ovoid.

Gnathosoma: Setae of palpal coxa, femur, and genu short, with few fine setules. Dorsal seta on palpal tibia fine with few setules; lateral seta fine with one or two fine setules; ventral seta with four or five fine setules. Palpal claw short, curved, stout, with three prongs, median longest and heaviest, but accessories stout. Tarsus small with four slender feathered setae and a tiny spur. Galeal seta fine with three to five fine setules. Cheliceral base slightly longer than broad; blade rather long and straight, curved at base and distal end; tiny dorsal tooth and larger ventral tooth distinct.

Legs: Leg I with a rather strong microgenuala on the distal dorsal surface and a single, fine genuala posterior to it. Tibia with two small tibialae set obliquely on the distal dorsal surface and a microtibiala posterior to the more distal of the two. Tarsus with a stout spur on its middorsal surface and a small microspur distal and slightly posterior to it; pretarsala small. Punctae few on segments 4, 5, and 6, not always apparent on coxa. Leg II with two short, blunt tibialae. Tarsus with a long, slender spur, a comparatively long microspur proximal to the spur, and a short pretarsala. Punctae few and large on coxa and segments 3, 4, and 5. Leg III with a slender, curving tibiala. Coxal seta on proximal half set well back from anterior margin; a few large punctae on coxa.

Scutum: About twice as wide as long. Anterior margin almost straight; lateral margins concave, curving posteriorly and laterally, posterior margin generally convex, slightly concave adjacent to the posterolaterals and medially. Setae slender with fine setules; anteromedian similar to anterolaterals and set well back from anterior margin; posterolaterals on slight elongations. Pseudostigmata near a line drawn connecting posterolaterals, varying from slightly anterior to slightly posterior, set apparently at an angle into the bases of short ridges arching over them anteromedially. Sensillae long, clavate, tapering from head to pedicel, widest about four-fifths the length from the base; covered with short, sharp setules which begin well down on the pedicel. Punctations lacking, but a small pit or pore present medial to each posterolateral seta.

Standard data of three paratypes from Santa Cruz County, Calif.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
47	68	21	24	22	13	18	25	29	-
49	75	25	26	23	13	23	28	32	34 x 11
46	64	22	17	19	14	22	-	38	36 x 10

Eyes: Two pairs in ocular plates; cornea not well defined on posteriors; diameter of anteriors about 9; of posteriors, 6.

Dorsal setae: Small, with short setules. Length of a humeral seta, 28; of a seta from the first row of posthumeral, 25; of a posterior seta, 19.

Dorsal formulae of two paratypes from Santa Cruz County, Calif.:

2 .. 6 .. 6 .. 6 .. 6 .. 2  
2 .. 6 .. 6 .. 6 .. 8 .. 4

Ventral setae: Sternals and poststernals anterior to anus with longer, finer setules than dorsals. Setae posterior to anus similar to dorsals. Length of a first sternal, 24; of a second sternal, 24; poststernals all about the same length, 19.

Ventral formulae of two paratypes from Santa Cruz County, Calif.:

2 .. 2 plus about 26  
2 .. 2 plus about 24

MATERIAL: One paratype borrowed from the Rocky Mountain Laboratory and two from the U. S. National Museum. Specimens from host:

*Sceloporus o. occidentalis*

Santa Cruz County, Calif., Aug. 15, 1945, 3.

DIAGNOSIS: *E. lacerta* differs from *E. bigenuala*, the other member of the "lacerta" group, by having a single genuala I, the microspur I distal to the spur, and the eyes in ocular plates.

REMARKS: *E. lacerta* is known from only one collection of four specimens, the type series. It is the only North American *Euschöngastia* reported from a cold-blooded vertebrate host.

## 2. *Euschöngastia bigenuala*, new species

FIGURE 4,a; PLATES 6, 9

DESCRIPTION: With the characters of the group.

Size: Length, 350; width, 235.

Shape: Oval.

Gnathosoma: Palps and chelicera similar to those of *E. lacerta*. Blade of chelicera more curved. Palpal claw with three prongs. Galeal seta with one setule.

Legs: Similar to *E. lacerta*. Genu I with two genualae, one dorsal and one posterior, and a rather long microgenuala. Microspur I proximal to spur. Spur I more distal than in *E. lacerta*. Tibialae shorter than in *E. lacerta*. All leg segments with conspicuous punctae.

Scutum: Generally similar to that of *E. lacerta*. Anterior margin concave with a slight convexity near the anterior median seta. Lateral margins more concave than in *E. lacerta* and the four corners more elongated. Pseudostigmata much closer together. Sensillae missing from specimen. Punctate. Cuticular striae appear to encroach on lateral margins.

Standard data of the holotype, from Galveston County, Tex.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
44	63	24	10	23	13	26	27	39	-

Eyes: Corneas of anterior eyes distinct; diameter, 9; posterior eyes indistinct. No ocular plate.

Dorsal setae: Similar to *E. lacerta*. Length of a humeral seta, 35; of a seta from the first posthumeral row, 36; of a posterior seta, 20.

Dorsal formula of the holotype: 2.6.6.6.6.4.

Ventral setae: More numerous than in *E. lacerta*. Length of a first sternal, 25; of a second sternal, 18; poststernals all about the same length, 18.

Ventral formula of the holotype: 2.2 plus about 40.

MATERIAL: Holotype only, USNM 1989. From host:

*Sigmodon* sp.

Galveston County, Tex., Aug. 8, 1947.

DIAGNOSIS: *E. bigenuala* differs from *E. lacerta*, the other member of the "lacerta" group, by lacking ocular plates, by having two genualae I, and by having its microspur I proximal to the spur.

REMARKS: Only one incomplete specimen of *E. bigenuala* has been collected. The very important sensillae are missing. However, the morphology of the group is so unusual and the correlation of *Euschöngastia bigenuala* with it is so complete that there can be little doubt of its position. *E. bigenuala* is named for the two genuala I which distinguish it from *E. lacerta*.

### 3. *Euschöngastia nuñezi* (Hoffmann)

PLATES 6, 10

*Neoschöngastia nuñezi* Hoffman, 1944, pp. 221-225, figs. 1-4.—Nuñez, 1947, pp. 221-237, 241-244, figs. 1-31.

*Euschöngastia nuñezi*, Fuller, 1952, p. 184.

DESCRIPTION: Size: Length, 490; width, 430.

Shape: Ovoid.

Gnathosoma: Seta on palpal coxa rather short with long setules. Seta on femur short with fine setules. Seta on genu nude. All three setae on tibia nude, fairly long. Palpal claw curved, cleft about half its length into two stout prongs, median prong stronger. Tarsus rather long; in addition to the usual setae a pointed seta about three-fourths as long as the spur is located on the medial ventral surface distal to the central of the three basal, feathered setae. Coxae punctate up to the galeae; femur punctate over its entire surface. Galeal seta long and nude. Cheliceral base strongly punctate. Cheliceral blade curved, with distinct teeth (Hoffmann, 1944); blade not present on specimen studied in U. S. National Museum.

Legs: Leg I with three genualae—two dorsal in tandem and one posterior—and a microgenuala. Tibia with two tibialae and a microtibiala and eight nonspecialized setae. Tarsus with strong tapered spur, a distal microspur, distinct subterminala and para-subterminala, and a pretarsala. Leg II with coxal seta set in from posterior margin, a genuala, two tibiala, a middorsal spur with proximal microspur, and a pretarsala. Leg III with a single genuala and single tibiala; tarsus with a single long mastitarsala on its dorsal surface near its base and 14 feathered setae. Setules of feathered setae of all legs straight. Coxae of all legs closely punctuate and all distal segments encircled with punctae.

Scutum: About three-fifths as long as broad; anterior margin sinuous; lateral margins slightly concave, diverge posteriorly; posterolateral corners slightly extended; posterior margin very slightly concave just medial to posterolaterals, deeply convex posterior to the pseudostigmata, and broadly concave between them; anterolateral setae not at the corners but set back on the lateral margins; anteromedian seta set well back from anterior margin; posterolaterals on the extended corners. All setae with short, scalelike setules. Pseudostigmata widely separated, slightly posterior to a line drawn between posterolaterals. Sensillae clavate, the pedicel expanding to a long, ovoid head widest about three-fourths its length from the base; head covered with very short, pointed setules. Surface without ridges; covered with punctae except for an almost clear zone near the anterior margin and around the anteromedian seta.

Standard data of the single paratype from México, D. F.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
62	79	19	36	30	18	36	41	63	38 x 13



Eyes: Two pairs in ocular plates lateral to the posterolateral setae; corneas distinct. Diameter of anterior eyes, 10; of posterior eyes, 9.

Dorsal setae: Similar in form to scutal setae; setules small. Length of a humeral, 50; of a seta from the first posthumeral row, 38; of a posterior seta, 36.

Dorsal formula of the single paratype: 2.6.6.4.4.2.

Ventral setae: Clearly of two forms; sternals and poststernals occupying the region just anterior to the anus similar to non-specialized leg setae, with rather long, straight setules on side opposite body; just anterior to the anus the form changes abruptly to that of the dorsal setae. Length of a first sternal, 44; of a second sternal, 42; of a seta from the first poststernal row, 37; of a posterior seta, 36.

Ventral formula of the single paratype: 2.2 plus about 19.

MATERIAL: A single paratype borrowed from the U. S. National Museum. From host:

Man

México, D. F., México, July 1944.

DIAGNOSIS: *E. nuñezi* is the only species of the genus now known in North America which has all nude setae on the palpal tibia, a pointed seta on the palpal tarsus in addition to the spur, and a mastitarsala III.

REMARKS: This species is known only from the original collections in México. It was found on man, parasitizing all members of one family, and on chickens in the same location. *E. nuñezi* is the only species of the genus in North America reported as a parasite on man.

#### 4. *Euschöngastia trigenuala*, new species

FIGURE 4,a; PLATES 4, 6, 10

DESCRIPTION: Size: Length, 480 to 510; width, 345 to 370.

Shape: Oval to ovoid.

Gnathosoma: Seta on palpal femur rather small with few setules. Genu with a curving, nude seta. Dorsal seta on tibia with a row of setules along its outer curvature; lateral seta nude; ventral seta rather small with few setules. Palpal claw curved, usually with five prongs, median prong longest, two accessories slightly shorter, and two smaller on the outer curvature. Cheliceral base heavy; blade with distinct subapical dorsal and ventral teeth. Galeal seta nude. Palpal coxae and cheliceral base punctate.

Legs: Genu I with three genualae on its dorsal surface, two in tandem near the anterior margin and one near the posterior margin, and a microgenuala about midway on a line between the posterior genuala and the more distal of the two in tandem. Tibia with two typical tibiala and a microtibiala. Tarsus with typically arranged spur, subterminala, parasubterminala, and pretarsala, but with the microspur proximal and slightly posterior to spur. Leg II with one genuala, two tibialae, the microspur slightly proximal and posterior to the spur, and a pretarsala. Seta on coxa III set back from margin; no genuala III; tibiala III present. Nonspecialized setae with straight, rather fine setules. Punctae on all segments of all legs. Empodium on all legs more slender than claws but about same length.

Anomalies: Parasubterminalae lacking and the base of one subterminala enlarged on one specimen. Subterminala sinuate on one specimen.

Scutum: Anterior margin slightly convex. Anterolateral corners extended in round lobes on which the short anterolateral setae are attached. Lateral margins diverge posteriorly, rounding abruptly just posterior to posterolaterals. Posterior margin shallowly convex posterolateral to each pseudostigma and shallowly concave between the two. Anteromedian seta set back slightly from anterior margin. All setae with short setules. Pseudostigmata deep, anterior to a line drawn between posterolaterals. Sensillae long clavate, enlarging evenly from the slender pedicel; widest in the distal quarter; rounded distally; clothed with few widely and irregularly spaced, heavy setules; one or two setules terminal. A broad inverted U-shaped ridge anterior to each pseudostigma. Spots or mottling present but punctae not evident. One or two small pits or pores usually just medial to the posterolateral setae.

Standard data for five specimens from University of Oklahoma:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
61	80	24	32	22	16	23	31	39	35 x 9 (type)
58	75	25	28	22	18	22	32	38	37 x 9
61	85	26	30	22	19	25	32	38	35
65	86	27	32	22	17	23	32	32	38
57	76	25	28	24	16	25	35	38	33 x 9

Eyes: Usually not distinguished. One pair on one specimen slightly anterior to posteroiateral setae. Diameter, 12. Pigment granules usually present.

Dorsal setae: Anterior setae rather slender with numerous fine setules, similar to scutal setae; nude on side adjacent to body; setules of posterior group somewhat heavier. Length of humerals

of five specimens, 44 to 48; of setae in the first posthumeral row, 34 to 40; and of setae in the posterior group, 38 to 45.

Dorsal formulae for five specimens collected at University of Oklahoma:

2 .. 9 .. 11 .. 10 .. 10 .. 2 .. 8 .. 6 .. 2 (type)  
 2 .. 10 .. 9 .. 9 .. 8 .. 7 .. 6 .. 2  
 2 .. 11 .. 9 .. 9 .. 10 .. 8 .. 6 .. 1  
 2 .. 10 .. 13 .. 11 .. 10 .. 8 .. 5 .. 2  
 2 .. 10 .. 11 .. 11 .. 12 .. 10 .. 7 .. 2

Ventral setae: Sternals with fine setules. Setae between sternals and anus small with fine setules. At level of the anus, setae abruptly become large, and similar to dorsals. Data for five specimens: Number of first sternals, 2; of second sternals, 2; of post sternals, 39 to 43. Length of first sternals, all 44; of second sternals, 29 to 36; of setae in the first post sternal row, 23 to 27; of setae in the posterior group, 38 to 45.

MATERIEL: Type, USNM 1990. Specimens from host:

*Scalopus* sp.

University of Oklahoma, Sept. 13, 1933 (USNM, type + 2; DU, 4; RML, 2; CEF, 2; KU, 1).

DIAGNOSIS: *Euschöngastia trigenuala* is the only species with the following combination of characters: A nude seta on the palpal genu, feathered dorsal and ventral setae on the palpal tibia, and microspur I proximal to spur. The scutum and the sensillae also are distinctive.

REMARKS: The data given under "material" includes all that is known about the collection.

*E. trigenuala* is named for the three genualae on genu I.

### 5. *Euschöngastia pipistrelli* Brennan

FIGURE 4,c; PLATES 6, 11

*Euschöngastia pipistrelli* Brennan, 1947, pp. 249-251, figs. 3A-D.—Fuller, 1952, pp. 182, 184.

*Euschöngastia miricoxa* Brennan, 1948, pp. 465, 468-469, 477, figs. 3A-E, 10.

DESCRIPTION: Size: Length, 287 to 780; width, 185 to 520.

Shape: Ovoid.

Color: Opaque white.

Gnathosoma: Seta on palpal femur with few, spaced setules. Seta on genu variable, with one to four setules, or nude. Dorsal seta on tibia with two to four setules; lateral seta nude or with one or two tiny setules; ventral seta rather small with setules; palpal claw with five prongs, occasionally four prongs, median longest and strongest, two slightly shorter, and two more proxi-

mal on the outer curvature. Galeal seta nude. Setae appear strong but frequently are broken off. Basal segment of chelicera heavy; blade large, curved, subapical dorsal and ventral teeth distinct. Punctae on palpal coxa and on chelicer base.

Legs: Leg I with two long, slender genualae and a microgenuala; two diagonally placed tibialae, the more distal one longer with typical microtibiala posterior to it; spur with microspur half length of spur or less distal, or distal and posterior; subterminala, parasubterminala, and pretarsala typically placed, long and strong. Leg II with one typical genuala, two tandem tibialae, a spur with proximal microspur, and a pretarsala. Leg III with single, slender genuala and tibiala. Leg segments robust, all with rather small punctae. Empodia more slender than the claws but about the same length. Feathered setae on the more proximal, free segments with rather long, curved setules; setules on feathered setae of tarsi generally straighter.

Scutum: Shape somewhat variable as lateral areas are extended more or less anteriorly. About twice as wide as long. Anterior margin generally concave with a convexity anterior to anterior median seta. Lateral margins concave, diverging posteriorly. Posterior margin extends more or less posteriorly, slightly concave behind the posterolaterals, convex posterior to the pseudostigmata, and usually slightly concave between them. The four corners somewhat extended. Setae long and heavy; anteromedian shortest, set close to anterior margin; posterolaterals exceptionally long; setules strong but rather widely spaced. Pseudostigmata well behind a line drawn between the posterolaterals. Sensillae broadly clavate; head well covered with long setules on the anterior surface, fewer on posterior surface; pedicels distinct. Surface covered with punctae; usually, a pair of larger pits medial to posterolaterals.

Standard data of the paratype from Stone County, Mo.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
60	80	25	22	35	11	70	45	109	32 x 16

Summary of standard data from 14 specimens from over the range, including the paratype (AL's from 12 specimens, AM's from 11, PL's from 13, S's from 6):

AW 60-80, mean 67.6; PW 76-103, mean 85.4; AP 16-25, mean 20.4; SB 22-37, mean 30.3; ASB 29-40, mean 34.4; PSB 8-13, mean 10.8; AL 44-70, mean 55.2; AM 36-50, mean 44.9; PL 104-126, mean 114; S 32-44, mean 39.2; width of sensilla 11-16, mean 13.7

Eyes: Usually not distinguished; one pair posterolateral to the posterolateral setae. Diameter about 6.

Dorsal setae: Long, curved; nude adjacent to body; long frag-

ile setules confined mostly to two alternate rows on the edge opposite the body. Rows irregular. Measurements from nine specimens: Length of humerals, 71 to 83; of setae near the middle of first posthumeral row .64 to .83; of posterior setae, 50 to 58.

Dorsal formulae of nine specimens:

Missouri	
Stone County:	2 .. 13 .. 9 .. 4 .. 11 .. 11 .. 8 .. 5 (paratype)
Illinois	
Jersey County:	2 .. 10 .. 9 .. 2 .. 8 .. 6 .. 2 .. 2
Ohio	
Clermont County:	2 .. 11 .. 12 .. .. 11 .. 7 .. 5
Kentucky	
Carter County:	2 .. 10 .. 11 .. .. 11 .. 8 .. 6 2 .. 11 .. 10 .. .. 11 .. 10 .. 6 .. 4
Pennsylvania	
Fayette County:	2 .. 13 .. 9 .. .. 16 .. 11 .. 6 .. 2
Warren County:	2 .. 12 .. 12 .. .. 10 .. 7 .. 2
McKean County:	2 .. 12 .. 11 .. .. 12 .. 8 .. 5 .. 4
New York	
Broome County:	2 .. 10 .. 11 .. 1 .. 11 .. 9 .. 5

Ventral setae: Form like that of the dorsals. Data from nine specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 36 to 54. Length of first sternals, 48 to 58; of second sternals, 37 to 47; of setae near the middle of the first post-sternal row, 26 to 37; of posterior setae, 44 to 54.

Anomalies: One specimen with three second sternals. One specimen with one second sternal and two setae on one coxa III.

MATERIAL: Paratype borrowed from Rocky Mountain Laboratory. All other specimens in Duke University collection. Specimens from hosts:

<i>Myotis l. lucifugus</i>	<i>Pipistrellus subflavus obscurus</i>
New York	Pennsylvania
Schoharie County: 1884, 7.	Warren County: Sept. 12, 1947, 1.
<i>Pipistrellus s. subflavus</i>	<i>Myotis keenii septentrionalis</i>
Missouri	Pennsylvania
Stone County: Sept. 11, 1946, 1 (paratype).	Warren County: Sept. 20, 1947, 2.
Ohio	McKean County: Aug. 6, 1948, 2.
Clermont County: Oct. 16, 1949, 25.	<i>Pipistrellus subflavus</i>
<i>Myotis lucifugus</i>	Pennsylvania
Pennsylvania	Westmoreland County: Jan. 3, 1948, 1.
Westmoreland County: Oct. 19, 1946, 4.	<i>Myotis keenii</i>
Fayette County: Mar. 30, 1947, 1.	Pennsylvania
<i>Myotis sodalis</i>	Fayette County: Feb. 24, 1948, 1.
New York	<i>Myotis</i> sp.
Broome County: Aug. 11, 1947, 2.	Illinois
	Jersey County: Mar. 4, 1948, 1.
	Kentucky
	Carter County: Aug. 20, 1948, 4.

**SEASONAL DISTRIBUTION:** This species has been collected through the three winter months of January, February, and March and through the late summer and early fall months of August, September, and October. Whether this seasonal pattern indicates population peaks or merely lack of collections during the other months is not known.

**GEOGRAPHIC DISTRIBUTION:** The range of *E. pipistrelli*, as it is known from collections, extends from southwestern Missouri, into Illinois, Kentucky, and Ohio, through southwestern and northwestern Pennsylvania, to southeastern New York (fig. 4,c).

**DIAGNOSIS:** *E. pipistrelli* is the only species with the following combination of characters: Five (or four) prongs on palpal claw, tibiala III present, two genualae I, one pair of indistinct eyes, and nude galeal seta. The very long, heavy, posterolateral setae and the long dorsal setae, sparsely clothed with long setules, are different from those of any other species.

**ECOLOGY:** A very limited amount of ecological information is available on *E. pipistrelli*. It has been collected only from bats which typically inhabit caves. Most of the specimens used in this study were removed from bats which were captured in caves.

Collectors report the chiggers attached to the inner surface of the ear, on the rim of the ear near the base, on the tragus, near the eyes, on the chin, and at the corners of the mouth.

**REMARKS:** *E. pipistrelli* varies in certain characters throughout its range.

The occurrence of nude and branched setae on the palpal genu is unusual. The list of dorsal setal formulae indicates some of the variation in this character. The shape of the scutum varies, usually by the projection anteriorly of the lateral margins and a narrowing of the distance between the anterolateral and the posterolateral setae.

*E. miricoxa* Brennan, 1948, was described from a single specimen, the holotype, removed from a bat, *Myotis l. lucifugus* (LeConte), on Aug. 5, 1947, in Tompkins County, N. Y. This specimen was not examined in this study. However, from a comparison of the published description, drawings, and photograph of the scutum with a paratype of *E. pipistrelli* and other specimens of the species collected in the East, it appears that the range of variation of *E. pipistrelli* would include *E. miricoxa*. The extension of coxa I described for *E. miricoxa* probably is an apodeme beneath the integument. It can be found in specimens of *E. pipistrelli* and in other species. The shape of the scutum is approximated by scuta of certain specimens of *E. pipistrelli*. The form and arrangement of the setae is similar in both, so far as can be deter-

mined by comparing specimens with drawings. A set of drawings of the legs of *E. miricoxa* was obtained from the Rocky Mountain Laboratory. The form of the segments and the form and arrangement of the striated setae are typical of *E. pipistrelli*. The locality from which *E. miricoxa* was taken falls within the range of *E. pipistrelli* (fig. 4,c). A consideration of the standard data of the type series, of specimens from east of the Mississippi River, and of *E. miricoxa* does indicate that there is generally a smaller AP measurement for the eastern specimens. The average of 10 AP measurements from the type series, which is western, is 24 (Brennan, 1947). The AP measurement of *E. miricoxa* is 17 (Brennan, 1948). The AP measurements of 13 eastern specimens include these extremes, but the mean is 20. There is some possibility of subspeciation, but further collections and study are required for proper evaluation. The two species are here considered to be the same and *E. miricoxa* to be a synonym of *E. pipistrelli*.

#### 6. *Euschöngastia oregonensis* (Ewing)

FIGURES 1, 2, 3, 4,a; PLATES 6, 11

*Trombicula oregonensis* Ewing, 1929a, p. 11; 1931, p. 9; 1942, p. 488.—Radford, 1942, p. 57.—Michener, 1946, p. 432.—Sig Thor and Willmann, 1947, pp. 260, 286.

*Euschöngastia oregonensis*, Fuller, 1948, p. 106; 1952, pp. 182-183, 184.

DESCRIPTION: Size: Engorged length, 505 to 535; width, 385 to 410.

Shape: Broad oval.

Gnathosoma: Rather small feathered seta on palpal femur. Seta on genu smaller, with few setules. Dorsal seta on palpal tibia longer with a few setules on its outer curvature; lateral seta with one to three setules; ventral seta with relatively few setules. Palpal claw curved with five prongs, median longest, two slightly shorter, and two shortest on the outer curvature. Galeal seta with one to three setules. Chelicera typical; subapical dorsal and ventral teeth distinct. Palpal coxa and femur and base of chelicera punctate.

Legs: Leg I with two typical genualae of moderate length and one microgenuala; two tibialae normally placed, the more proximal tibiala longer, and a microtibiala slightly posterior to the distal tibiala; strong spur on the middorsal surface of the tarsus with microspur about half the length of the spur distal and slightly posterior; subterminala, parasubterminala, and pretarsala typical. Leg II with one typical genuala, two tibialae in tandem, a strong spur with proximal microspur, and a pretarsala. Leg III with single, typical genuala and tibiala. Setules mostly

broken off the nonspecialized setae. Leg segments stout, rounded in legs I and II; all segments with punctae. Empodium about the same length as the claws.

Scutum: About twice as wide as long, slightly pointed at the posterolateral corners. Anterior margin straight with anterolateral corners extended and a small convexity anterior to the anteromedian seta. Lateral margins concave, diverging posteriorly. Posterior margin convex posterior to each pseudostigma and shallowly concave medially. Anterolateral and posterolateral setae set on extended corners. Anteromedian seta close to anterior margin. Posterolaterals longest; anteromedian shortest. Fine setules on all setae. Pseudostigmata rather widely separated, posterior to a line drawn between the posterolaterals. Sensillae broadly clavate, widest about three-fourths the length from the base; pedicel rather long and distinct; expanded portion covered with setules, fewer on posterior surface. Crescentic ridges indicated anterior to pseudostigmata. Surface punctate; in these specimens wide margins surround the punctae.

Standard data for the five specimens of the type series from Benton County, Oreg.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
65	86	23	33	28	12	34	30	46	
70	92	23	38	30	14	40	30	56	35x14 (lectotype)
68	93	26	38	27	14	38	32	52	
73	99	25	41	31	13	37	31	47	34
69	95	25	38	27	13	38	32	50	

Eyes: Two pairs, distinct but rather small; anterior and posterior eyes about the same diameter, 7.

Dorsal setae: Setae with rather fine setules of moderate length except the posterior group. Posteriors with fewer, shorter setules; end bluntly or with V-clefts. Measurements from five specimens: Length of humerals, 48 to 52; of setae near the middle of the first posthumeral row, 43 or 44; of setae in the posterior group, 43 to 45.

Dorsal formulae for five specimens of the type series from Benton County, Oreg.:

2	..	10	..	11	..	..	9	..	..	8	..	6	..	2		
2	..	11	..	?	..	..	?	..	..	?	..	?	..	?	(lectotype)	
2	..	12	..	13	..	2	..	9	..	2	..	8	..	6	..	2
2	..	10	..	10	..	2	..	8	..	2	..	8	..	2	..	2
2	..	11	..	10	..	2	..	9	..	..	8	..	6	..	2	

Ventral setae: General character similar to that of the dorsals. Data from five specimens: Number of first sternals, 2; of second



sternals, 2; of poststernals, 47 to 50. Length of first sternals, 47 to 59; of second sternals, 35 to 36; of setae near the middle of the first poststernal row, 25 to 26; of setae in the posterior group, 41 to 44.

**MATERIAL:** All cotypes in USNM (type No. 990). Specimens from host:

Mole

Benton County, Oreg., May 17, 1912, 5 (cotypes).

**DIAGNOSIS:** *E. oregonensis* can be distinguished by the following combination of characters: Tibiala III, subterminala and para-subterminala I, and two genualae I present; five prongs on palpal claw; two pairs of eyes; galeal seta branched; lateral seta on palpal tibia branched. It is very close to *E. samboni*, as the species are now defined, but it can be distinguished by the smaller setae on its gnathosoma and the branched lateral seta on its palpal tibia.

**REMARKS:** The original description of *E. oregonensis* is a description of a chigger typical of the genus *Trombicula*. The type host is given as a mole and the type locality as Corvallis, Oreg. The type slide is given as No. 990, U. S. National Museum. However, the specimens from the type slide, type host, and type locality, as indicated, are *Euschöngastia*. Fuller (1948), after examining the type specimens, placed the species in the genus *Euschöngastia*. The original description is not adequate for identification of the chiggers from the slide, but it does validate the name. The type specimen or specimens are the name bearers for the species. Therefore, Fuller's combination is here considered to be correct and the name of the species to be *Euschöngastia oregonensis* (Ewing, 1929).

The specimen of the cotypal series found on the slide marked "C. E. F. X." is here designated lectotype.

#### 7. *Euschöngastia samboni* (Radford)

FIGURE 4,a; PLATES 8, 20

*Neuschöngastia samboni* Radford, 1942, pp. 76-77, fig. 99; 1947a, pp. 579, 599-600, figs. 27, 28; 1947b, p. 275.

*Euschöngastia samboni*, Brennan, 1948, p. 476.—Fuller, 1952, pp. 182, 184.

**DESCRIPTION:** Size: Length, 300 to 570; width, 200 to 510.

Shape: Ovoid to very broad oval.

Gnathosoma: Seta on palpal femur strong, with moderate number of setules. Seta on palpal genu smaller with relatively

few setules. Dorsal seta on palpal tibia strong and arching with few setules on its outer curvature; lateral seta on tibia nude; ventral seta with relatively few setules. Palpal claw strong, curved, usually with five prongs, occasionally four. Galeal seta strong, usually with one or two long, strong setules; occasionally nude. Cheliceral base heavy, blade strong and curved; dorsal subapical tooth small but distinct, ventral tooth larger. Rather small punctae on cheliceral base, palpal coxa, and palpal femur.

Legs: Leg I with two typical genualae and microgenuala, two typical tibialae and a microtibiala, a middorsal spur, a distal microspur, a subterminala, a parasubterminala, and a pretarsala. Leg II with one genuala and two tibialae, a tarsal spur, a proximal microspur, and a pretarsala. Leg III with a genuala and a tibiala, relatively short. Most nonspecialized setae on the free segments of leg I with numerous, rather short, fine, curved setules; on leg II the dorsal nonspecialized setae tend to have fewer, straighter setules; both types on leg III. Leg segments strong; legs without marked taper. All segments with punctae.

Scutum: Similar in general outlines and proportions to that of *E. oregonensis*. Anterior margin straight or slightly concave between the extended anterolateral corners and the small convexity just anterior to the anteromedian seta. Lateral margins concave, diverging posteriorly. Posterolateral corners extended. Posterior margin convex posterior to the pseudostigmata and slightly concave between them. Setae well clothed with moderate setules; anterolaterals and anteromedian setae about the same length, about half the length of the long posterolaterals. Pseudostigmata moderately separated; posterior to a line drawn between the posterolaterals. Sensillae clavate, widest about two-thirds the length from the base; heads tend to be slightly pointed, covered with rather long, smooth setules on the anterior surface and shorter, more offstanding setules on the posterior surface; pedicels distinct. Distinct inverted U-shaped ridge anterior to each pseudostigma, lateral leg extending to posterior margin. Surface with punctae, more numerous within the area inclosed by the crescentic ridges. One or two larger pits near the posterolateral terminus of each ridge.

Standard data for the three specimens studied from Ravalli County, Mont.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
71	96	27	33	35	13	44	44	90	38 x 16 (paratype)
63	90	29	27	32	14	43	43	64	38
65	87	25	34	30	12	45	41	71	-

Eyes: Two pairs lateral to the posterolaterals; no ocular plate. Diameter of anterior eyes, 10 to 12, mean 10.3; of posteriors, 8 to 10, mean 8.3.

Dorsal setae: Posterior group different in form from the anterior setae; anteriors well clothed with setules on the side opposite the body; posterior group with fewer, shorter setules exposing the shaft. Measurements from three specimens: Length of humerals, 61 to 72; of setae near the middle of the first post-humeral row, 50 to 57; of setae in the posterior group, 37 to 47.

Dorsal formulae of three specimens from Ravalli County, Mont.:

2 .. 12 .. 11 ..	2 .. 11 ..	7 ..	2 ..	2 (paratype)
2 .. 13 .. 14 ..	.. 12 .. 11 ..	8 ..	2	
2 .. 11 .. 15 ..	.. 12 ..	8 ..	5 ..	4

Ventral setae: Generally similar to dorsals. Data from three specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 52 to 60. Length of first sternals, 50 to 57; of second sternals, 40 to 44; of setae near the middle of the first poststernal row, 30 to 44; of setae in the posterior group, 33 to 47.

Anomaly: One specimen with three second sternals.

MATERIAL: Paratype in the U. S. National Museum; other specimens from the Rocky Mountain Laboratory now deposited in the Duke University collection. Specimens from hosts, all from Montana:

Pika  
Ravalli County: Dec. 2, 1933, 1  
(paratype).

<i>Ochotona p. princeps</i>
Ravalli County: Dec. 2, 1933, 1.
<i>Clethrionomys</i> sp.
Ravalli County: Oct. 12, 1945, 1.

SEASONAL DISTRIBUTION: *E. samboni* has been collected in fall and winter, October and December.

GEOGRAPHIC DISTRIBUTION: *E. samboni* has been collected only in Ravalli County, Mont. (fig. 4,a).

DIAGNOSIS: *E. samboni* can be distinguished by the following combination of characters: Tibiala III, subterminala and para-subterminala I, and genualae I present; five prongs, usually, on the palpal claw; two pairs of eyes; galeal seta usually branched; lateral seta on palpal tibia nude. *E. samboni* is very close to *E. oregonensis*, as the species are now defined. In the specimens studied, all the setae of the gnathosoma of *E. samboni* are larger; the galeal seta is heavier and the setules longer; and the lateral seta on the palpal tibia is nude.

REMARKS: The close morphological similarity between *E. samboni* and *E. oregonensis* has been indicated in the descriptions of both species. The localities from which the two have been collected are widely separated in miles but are in the same general geographic area (fig. 4,a). Collections of both species are scant. Further collections are necessary to determine the relationship between the two forms.

### 8. *Euschöngastia peromysci* (Ewing)

FIGURES 4,a, 5,a,b, 6,c,g,h; PLATES 6, 12

*Schöngastia peromysci* Ewing, 1929c, pp. 296-297.

*Neoschöngastia peromysci*, Ewing, 1931, p. 5.—Radford, 1942, p. 72.—Sig Thor and Willmann, 1947, pp. 311, 313.

*Neoschöngastia signator* Ewing, 1931, pp. 14-15, 19, pl. 2, fig. 1.—Radford, 1942, pp. 72, 74, 75, fig. 80.—Sig Thor and Willmann, 1947, pp. 311, 313, fig. 374.

*Neoschöngastia brevipes* Ewing, 1931, pp. 16, 19, pl. 2, fig. 4.—Radford, 1942, pp. 72, 74, 75, fig. 81.—Sig Thor and Willmann, 1947, pp. 311, 313, fig. 376.

*Trombicula peromysci*, Michener, 1946, p. 432.

*Euschöngastia peromysci*, Fuller, 1948, p. 108; 1952, p. 184.—Brennan, 1948, p. 470.

*Euschöngastia signator*, Fuller, 1948, p. 108; 1952, p. 184.

*Euschöngastia brevipes*, Fuller, 1948, p. 108; 1952, p. 183.

DESCRIPTION: Size: Length, 225 to 750; width, 115 to 565.

Shape: In life unattached, unengorged chiggers slightly flattened oval, widest at the third pair of legs; engorged, oval. Preserved on slides, oval to ovoid.

Color: Unengorged chiggers, cream or light yellow; engorged, opaque white. Red eyes.

Gnathosoma: Seta on palpal femur strong, curved, well clothed with setules except on the concave margin. Seta on genu curved, with two or three rows of strong, alternately arranged setules on the convex curvature. Dorsal seta on tibia curved, with two alternate rows of setules; lateral seta with a few setules which tend to arise near the base; ventral seta with about five alternate rows of strong setules over the dorsal surface of the shaft. Setules on all setae appear strong and stiff. Palpal claw slightly curved, three-pronged, the middle prong longer and heavier, the two accessories arising near middle of the claw and lying close against the median prong; length somewhat variable through the range of the species (fig. 5,b). Galeal seta of distinctive appearance, curving, bristlelike, usually with one to three stiff setules arising on the outer margin near the base; number of setules variable within about the same limits throughout the range with a ten-

dency to fewer setules from south and west to north and east (table 6). Chelicera with typical heavy base, curved blade, and distinct subapical dorsal and ventral teeth. Cheliceral base and palpal coxa and femur punctate.

Legs: Striated setae in typical arrangement. Leg I with two genualae and a microgenuala, two tibialae and a microtibiala, a spur and a distal microspur, a subterminala, a parasubterminala, and a pretarsala. Leg II with a genuala, two tibialae, a spur, a proximal microspur, and a pretarsala. Leg III with a genuala and a tibiala. All specialized setae strong and clear. Nonspecialized setae on free segments beyond the trochanters rather short but strong, with long, curved setules in regular alternate pattern. All leg segments with punctae.

Anomalies: One specimen with two setae on one coxa III. One specimen with three genualae on one genu I. One specimen with three tibialae I on one leg. One specimen with only one tibiala II on one leg. One specimen with a parasubterminala I equal in size to the subterminala. One specimen with the tibiala III missing from one leg.

Scutum: About a third to a fourth wider than long. Anterior margin broad W-shaped with the anterolateral setae and the anteromedian seta on the anterior extensions. Lateral margins concave, short, diverge slightly posteriorly. Posterolateral corners, very slightly extended, bear the posterolateral setae. Posterior margin usually rather deeply rounded posterior to each pseudostigma and shallowly concave between the two. Margins sometimes so pared that scutum appears skimpy. Setae densely covered with setules. Pseudostigmata well behind a line drawn between the posterolateral setae. Sensillae abruptly expanded, capitate; pedicels nude; heads covered with rather short setules. Anterior to each pseudostigma an inverted U-shaped ridge, the medial and lateral legs terminating about on a line with the posterior edges of the pseudostigmata; the two ridges sometimes continuous medially. Surface punctate. Sometimes with cuticular striae over the posterior margin. Apparently a tendency for scuta to become larger from south and west to north and east in the specimens from the area studied (fig. 5,a).

Summary of standard data from 100 specimens of *E. peromysci* from over its range (AL's from 99 specimens, AM's from 92, and S's from 59) :

AW 41-60, mean 50.2; PW 48-71, mean 56.6; AP 10-17, mean 13.5;  
SB 17-32, mean 22.5; ASB 21-32, mean 27.3; PSB 6-12, mean 8.5;  
AL 27-42, mean 34.9; AM 21-38, mean 26.8; PL 37-57, mean 46.4;  
S 25-30, mean 27.1.

TABLE 6.—Distribution of setules on 580 galeal setae of *Euschöngastia peromysci* from 25 counties in Oklahoma, Ohio, Kentucky, North Carolina, Maryland, Pennsylvania, and Massachusetts

No. of setules per galeal seta	Frequency																								
	Latimer, Okla. <i>Cotype L. signator</i>	McKean, Pa.	Prince Georges, Md. <i>Cotydes E. brevipes</i>	Clermont, Ohio	Rowan, Ky.	Durham, N. C.	Orange, N. C.	Lancaster, Pa.	Montroe, Pa.	Wayne, Pa.	York, Pa.	Cameron, Pa.	Venango, Pa.	Clearfield, Pa.	Sullivan, Pa.	Bradford, Pa.	Worcester, Mass. <i>Type L. peromysci</i>	Lycoming, Pa.	Jefferson, Pa.	Westmoreland, Pa.	Union, Pa.	Bedford, Pa.	Schuylkill, Pa.	Center, Pa.	Pike, Pa.
0	-----	-----	-----	-----	-----	-----	-----	-----	1	-----	-----	-----	1	1	-----	-----	-----	5	2	-----	-----	-----	-----	-----	-----
1	-----	-----	-----	-----	-----	5	11	-----	1	-----	-----	2	21	1	1	1	-----	44	15	6	7	2	3	2	2
2	-----	-----	-----	-----	-----	15	27	2	-----	2	2	3	79	10	7	7	1	53	12	7	4	4	2	2	1
3	-----	1	2	1	-----	3	34	2	3	2	1	2	46	4	2	1	-----	29	12	2	3	-----	1	-----	-----
4	-----	1	1	-----	-----	7	8	-----	-----	-----	-----	1	12	1	-----	-----	-----	6	1	-----	-----	-----	-----	-----	-----
5	-----	1	-----	-----	-----	2	1	-----	-----	-----	-----	-----	2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Total	2	2	3	1	6	37	81	4	4	4	3	8	161	17	10	9	1	137	42	15	14	6	6	4	3
Mean	4.5	3.5	3.3	3.0	2.8	2.6	2.5	2.5	2.5	2.5	2.3	2.3	2.3	2.2	2.1	2.0	2.0	1.9	1.9	1.7	1.7	1.7	1.7	1.5	1.3

**Anomalies:** One specimen with two anteromedian setae. One specimen wider between the anterolaterals than between the posterolaterals.

**Eyes:** Two pairs; anterior pair lateral to posterolateral setae. Diameter of anterior eyes for 20 specimens, 7 to 10, mean 8.4; of posterior eyes, 7 to 11, mean 8.3. Diameter of both anterior and posterior eyes of a cotype of *E. signator*, 12.

**Dorsal setae:** Setae well covered with setules on sides away from body. Posterior setae with slightly fewer setules, tending to terminate in V-shaped clefts, but of the same general form as the other dorsals. In unengorged specimens humerals not distinctly set off from first posthumeral row. Length of humerals of 90 specimens, 37 to 51; of setae near the middle of the first row of posthumerals, 35 to 50; of setae in the posterior group, 27 to 36.

Dorsal formulae for 26 specimens, including a fairly typical specimen from each county:

## Oklahoma

Latimer County: 2 .. 11 .. 15 .. 2 .. 12 .. 2 .. 10 .. 8 .. 6

## Ohio

Clermont County: 2 .. 10 .. 14 .. .. 12 .. .. 7 .. 8 .. 4

## Kentucky

Rowan County: 2 .. 10 .. 14 .. .. 12 .. .. 12 .. 8 .. 5

## North Carolina

Durham County: 2 .. 10 .. 12 .. .. 12 .. .. 12 .. 8 .. 4

Orange County: 2 .. 10 .. 13 .. .. 16 .. .. 13 .. 8 .. 4

## Maryland

Prince Georges County: 2 .. 10 .. 15 .. 2 .. 7+ .. 9 .. 6 .. 5

## Pennsylvania

Bedford County: 2 .. 10 .. 12 .. 2 .. 12 .. .. 10 .. 7 .. 4

York County: 2 .. 10 .. 14 .. .. 12 .. .. 10 .. 9 .. 5

Lancaster County: 2 .. 9 .. 14 .. .. 14 .. .. 11 .. 10 .. 8

Westmoreland County: 2 .. 10 .. 12 .. .. 14 .. .. 12 .. 8 .. 5

Indiana County: 2 .. 10 .. 16 .. .. 15 .. .. 13 .. 9 .. 7

Jefferson County: 2 .. 10 .. 14 .. 2 .. 13 .. .. 14 .. 10 .. 6

Clearfield County: 2 .. 10 .. 14 .. .. 15 .. .. 12 .. 9 .. 4

Cameron County: 2 .. 10 .. 14 .. .. 17 .. .. 12 .. 9 .. 5

McKean County: 2 .. 10 .. 12 .. .. 10+ .. 9+ 6 .. 4

Beaver County: 2 .. 10 .. 14 .. .. 13 .. .. 9 .. 8 .. 5

Venango County: 2 .. 10 .. 13 .. 2 .. 13 .. .. 12 .. 9 .. 5

Center County: 2 .. 10 .. 16 .. .. 14 .. .. 11 .. 9 .. 5

Union County: 2 .. 10 .. 15 .. .. 13 .. .. 10 .. 8 .. 4

Schuylkill County: 2 .. 10 .. 15 .. .. 13 .. .. 10 .. 8 .. 4

Lycoming County: 2 .. 10 .. 14 .. .. 14 .. .. 9 .. 7 .. 4

Sullivan County: 2 .. 10 .. 13 .. .. 14 .. .. 9 .. 9 .. 2

Bradford County: 2 .. 10 .. 15 .. .. 14 .. .. 9 .. 7 .. 3

Monroe County: 2 .. 10 .. 14 .. .. 12 .. .. 12 .. 9 .. 5

Pike County: 2 .. 11 .. 15 .. .. 12 .. .. 9 .. 7 .. 6

Wayne County: 2 .. 10 .. 15 .. .. 12 .. .. 10 .. 8 .. 6

Ventral setae: Form of poststernal setae similar to that of the dorsals. Data from 90 specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 49 to 75. Poststernals in a cotype of *E. signator*, 75. Length of first sternals, 36 to 49; of second sternals, 25 to 43; of setae near the middle of the first poststernal row, 19 to 29; of setae in the posterior group, 25 to 36.

Anomalies: Four specimens with three second sternals. One specimen with one rudimentary first sternal bearing two tiny setules.

MATERIAL: Type material of *E. peromysci*, *E. signator*, and *E. brevipes* in the U. S. National Museum; all other specimens in the Duke University collection. From hosts and unattached:

*Peromyscus leucopus noveboracensis*  
Massachusetts

Sturbridge: May 27, 1928, 1  
(Holotype).

Pennsylvania

Beaver County: May 1947, 6.  
Mercer County: July 1947, 1.  
Venango County: Feb. 1948, 4;  
Mar. 1948, 3.  
Clearfield County: Apr. 1949, 4.

Wood rat

Oklahoma

Wilburton: Mar. 17, 1949, 2  
(Cotypes *E. signator*).

*Peromyscus leucopus*

Maryland

College Park: May 3, 1929, 4  
(Cotypes *E. brevipes*).

Pennsylvania

Monroe County: July 1947, 1.

North Carolina

Durham County: Jan. 1948, 3;  
May 1948, 9; June 1948, 3;  
Sept. 1948, 1; Dec. 1948, 47;  
Jan. 1949, 8; Feb. 1949, 13;  
Mar. 1949, 6; Apr. 1949, 15;  
June 1949, 8; Sept. 1949, 4.  
Orange County: Dec. 1948, 3;  
May 1948, 3; July 1948, 1;  
Nov. 1948, 9; Dec. 1948, 3;  
Jan. 1949, 17; Feb. 1949, 21;  
Mar. 1949, 27; Apr. 1949, 10;  
May 1949, 5; June 1949, 8;  
July 1949, 16; Aug. 1949, 2.

*Clethrionomys gapperi*

Pennsylvania

Wayne County: July 1945, 3.  
Monroe County: July 1947, 8.  
Pike County: July 1947, 1.  
Sullivan County: Oct. 1949, 29.

*Clethrionomys gapperi paludicola*

Pennsylvania

Venango County: Apr. 1947, 64;  
May 1947, 64; Feb. 1948, 15;  
Mar. 1948, 87.  
Westmoreland County: Feb. 1948,  
7.  
Jefferson County: Apr. 1948, 8;  
May 1948, 33.

*Sorex f. fumeus*

Pennsylvania

Venango County: Apr. 1947, 2.

*Microtus p. pennsylvanicus*

Pennsylvania

Venango County: Apr. 1947, 13.  
Lycoming County: Jan. 1949, 11.  
Clearfield County: Apr. 1949, 9.

*Blarina b. brevicauda*

Pennsylvania

Venango County: May 1947, 1.  
Clearfield County: May 1949, 1.

*Tamias striatus*

Pennsylvania

Monroe County: July 1947, 1.  
Pike County: July 1947, 2.

*Peromyscus maniculatus*

Pennsylvania

Pike County: July 1947, 1.



- Forest litter  
North Carolina  
Durham County: Feb. 1948, 1.
- Pitymys pinetorum scalopsoides*  
Pennsylvania  
Venango County: Feb. 1948, 8.  
York County: Apr. 1949, 5.
- Surface soil  
North Carolina  
Durham County: Feb. 1948, 1.  
Orange County: Jan. 1950, 8.
- Soil—mammal burrow  
North Carolina  
Durham County: Feb. 1948, 1.
- Peromyscus maniculatus bairdii*  
Pennsylvania  
Venango County: Feb. 1948, 12.
- Peromyscus* sp.  
Pennsylvania  
Westmoreland County: Feb. 1948, 5.  
Cameron County: Sept. 1949, 2.  
Bradford County: Oct. 1949, 1.
- Kentucky  
Rowan County: Aug. 1948, 3.
- Tamias striatus lysteri*  
Pennsylvania  
Venango County: Mar. 1948, 19.  
Jefferson County: May 1948, 27.  
McKean County: July 1948, 1.
- Tamiasciurus hudsonicus loquax*  
Pennsylvania  
Venango County: Mar. 1948, 2.
- Mammal runway  
North Carolina  
Orange County: Mar. 1948, 1.
- Mammal burrow  
North Carolina  
Orange County: Mar. 1948, 1.
- Neotoma magister*  
Kentucky  
Rowan County: Aug. 1948, 2.
- Pennsylvania  
Union County: May 1949, 2.
- Clethrionomys* sp.  
Pennsylvania  
Indiana County: Sept. 1948, 6.  
Cameron County: Sept. 1949, 10.  
Lancaster County: Sept. 1949, 16.
- Monroe County: Sept. 1949, 3.  
Bradford County: Oct. 1949, 4.  
Schuylkill County: Nov. 1949, 4.  
Bradford County: Nov. 1949, 18.
- Tamias striatus ohionensis*  
Ohio  
Clermont County: Oct. 1948, 3.
- Cavities of decayed root systems and under stumps  
North Carolina  
Orange County: Dec. 1948, 12.  
Orange County: Mar. 1949, 3.  
Durham County: Mar. 1949, 2.  
Orange County: Mar. 1950, 10.
- Forest soil  
North Carolina  
Orange County: Dec. 1948, 7.
- Clethrionomys g. gapperi*  
Pennsylvania  
Lycoming County: Jan. 1949, 122;  
Mar. 1949, 35; May 1949, 32.  
Westmoreland County: Jan. 1949, 8.  
Clearfield County: Apr. 1949, 38;  
May 1949, 3.  
Indiana County: Apr. 1949, 14.  
Bedford County: May 1949, 13.  
Union County: May 1949, 58.  
Center County: June 1949, 6.
- Humus under log  
North Carolina  
Orange County: Jan. 1949, 2.  
Durham County: Feb. 1949, 1.
- Peromyscus maniculatus nubiterrae*  
Pennsylvania  
Lycoming County: Mar. 1949, 3.
- Sciurus c. carolinensis*  
North Carolina  
Orange County: Mar. 1949, 2.
- Pitymys p. pinetorum*  
North Carolina  
Durham County: Apr. 1949, 3.
- Synaptomys cooperi stonei*  
Pennsylvania  
Clearfield County: Apr. 1949, 7.  
Indiana County: Apr. 1949, 1.
- Tamias* sp.  
Pennsylvania  
Cameron County: Aug. 1949, 6.

*Pitymys* sp.

## Pennsylvania

Cameron County: Sept. 1949, 3.

Monroe County: Sept. 1949, 1.

Bradford County: Nov. 1949, 14.

Leaf nest in log

## North Carolina

Orange County: Oct. 1949, 7.

Durham County: Mar. 1950, 2.

*Microtus chrotorrhinus*

## Pennsylvania

Sullivan County: Oct. 1949, 4.

*Ondatra zibethica*

## North Carolina

Durham County: Nov. 1949, 2.

Soil (7 to 15 cm. depth?)

## North Carolina

Orange County: Jan. 1950, 2.

SEASONAL DISTRIBUTION: In North Carolina *E. peromysci* has been collected from hosts in every month of the year except October (fig. 6,c). There is a record of unattached chiggers for October. The species is much more abundant on hosts during the winter and spring months.

GEOGRAPHICAL DISTRIBUTION: The range of *E. peromysci*, based on known collections, extends from Oklahoma in the southwest and North Carolina in the south to Massachusetts in the northeast (fig. 4,a).

DIAGNOSIS: *E. peromysci* can be distinguished by the following combination of characters: Tibiala III present, subterminala and parasubterminala I present, palpal claw with three prongs, no mastitarsala III, sensillae capitate, and scutum with two ridges, one anterior to each pseudostigma. Through the range known at the present time, the shape of the scutum and the characteristic galeal setae will separate *E. peromysci* from other known *Euschöngastia* species.

ECOLOGY: Mr. Neil Richmond has supplied information concerning areas in which *E. peromysci* was collected in Pennsylvania. The chiggers commonly were taken from hosts trapped in situations where hemlock was a dominant tree. Associated trees in the various areas included yellow and black birch, red maple, and oaks. The sites frequently were ravines or slopes with northern or partially northern exposures. Moisture was ample to abundant; springs and brooks were usually present. The forest floor held a moderate to deep layer of humus. Logs and fallen branches were abundant. Most collections were made from *Clethrionomys gapperi*.

In the Duke Forest area *E. peromysci* was taken from its hosts trapped in upland hardwoods (pl. 1) in all exposures and in the narrow bottomlands along streams. Generally the topography of this area is gently rolling, cut by four permanent streams. The forest floor holds a moderate amount of humus, fallen branches, decaying logs, and fallen trees. Stumps in varying stages of decay are common, as are cavities and passageways left by decayed stumps and root systems (pl. 2).

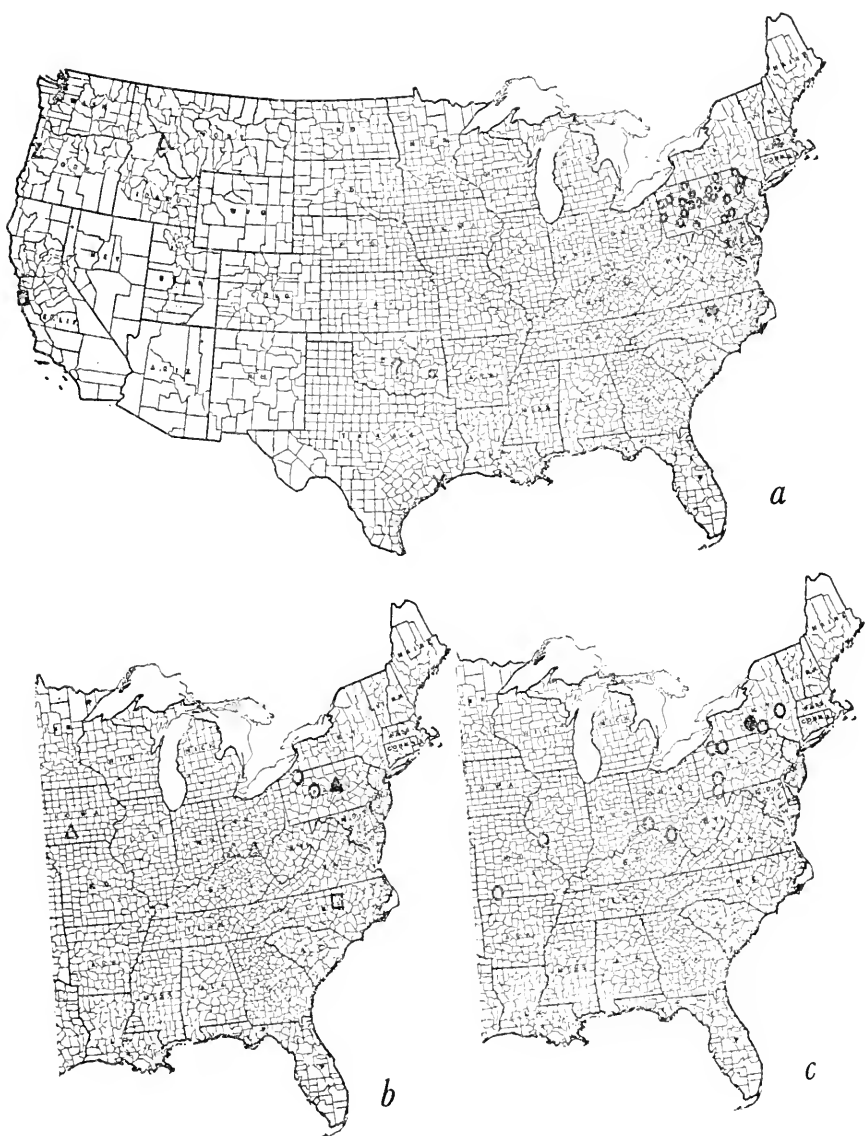


FIGURE 4.—Maps showing: a, distribution of *Euschöngastia lacerta*, □; *E. bigenuala*, X; *E. samboni*, △; *E. cordiremus*, ▽; *E. oregonensis*, Z; *E. peromysci*, ○; and *E. trigenuala*, γ, b, distribution of the "rubra" group: *E. rubra*, □; *E. diversa diversa*, △ and ▴; *E. diversa acuta*, ○; and *E. magna*, ▴; c, distribution of *E. pipistrelli*, ○; and *E. miricoxa* = *E. pipistrelli*, ●.

Evidence indicates that *E. peromysci* is a forest soil dweller in the Duke Forest area. All collections of the unattached, unengorged chiggers have been from forest soil situations (table 5). Whether its principal host, *Peromyscus leucopus*, is a soil dweller in Duke Forest has not been proved, but circumstantial evidence from the traplines—the frequency with which it was trapped around decayed stumps, at the bases of fallen trees, and at small holes in the forest floor—indicates that it is.

Collection records show that *E. peromysci* has been most abundant during the coldest seasons of the year. Figure 6,c, constructed from the occurrence of the chiggers in collections, reflects the trend of seasonal populations. However, three chiggers on one host in a June collection influenced the graph as much as perhaps fifty chiggers on every host of a January collection. The result has been a much-flattened graph without the amplitude that it would have had if based on counts of the chiggers.

Results of preliminary investigations into factors controlling seasonal distribution of *E. peromysci* indicate that it had its peak population during the season when temperatures of air, surface soil, and subsoil (three inches depth) were lowest (fig. 6,e).

#### EXPLANATION OF FIGURE 5

- a, Variation geographically in the size of scutum in 100 specimens of *Euschöngastia peromysci*. Vertical axis: Size of scutum, PW + ASB + PSB (width + length), in microns. The means are indicated by crosslines. Horizontal axis: Counties, with the number of scuta measured for each: A, Rowan County, Ky.; B, Orange County, N. C.; C, Durham County, N. C.; D, Clermont County, Ohio; E, York County, Pa.; F, Cameron County, Pa.; G, Prince Georges County, Md.; H, Bradford County, Pa.; I, Sullivan County, Pa.; J, Monroe County, Pa.; K, Westmoreland County, Pa.; L, Lancaster County, Pa.; M, Lycoming County, Pa.; N, Union County, Pa.; P, Jefferson County, Pa.; Q, Schuylkill County, Pa.; R, Bedford County, Pa.; S, Clearfield County, Pa.; T, McKean County, Pa.; U, Venango County, Pa.; V, Wayne County, Pa.; W, Indiana County, Pa.; X, Center County, Pa.; Y, Beaver County, Pa.; Z, Pike County, Pa.
- b, Variation geographically in the length of 70 palpal claws of *Euschöngastia peromysci*. Vertical axis: Length of the claws in microns. The means are indicated by crosslines. Horizontal axis: Counties with the number of separate palpal claws measured from each: A, Clermont County, Ohio; B, Rowan County, Ky.; C, York County, Pa.; D, Lancaster County, Pa.; E, Durham County, N. C.; F, Orange County, N. C.; G, Westmoreland County, Pa.; H, Union County, Pa.; I, Lycoming County, Pa.; J, Cameron County, Pa.; K, Bedford County, Pa.; L, Jefferson County, Pa.; M, Venango County, Pa.; N, Clearfield County, Pa.; P, McKean County, Pa.; Q, Sullivan County, Pa.; R, Monroe County, Pa.
- c, Variation geographically in the size of scutum of 20 specimens of *Euschöngastia diversa diversa*. Vertical axis represents size of scutum, PW + ASB + PSB (width + length), in microns. Horizontal axis: A, Clarke County, Iowa; B, Clermont County, Ohio; C, Scioto County, Ohio; D, Union County, Pa. Five scuta were measured for each county. The means are indicated by crosslines.

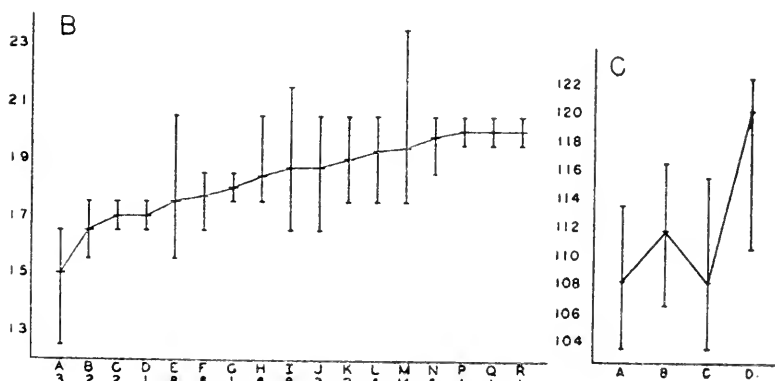
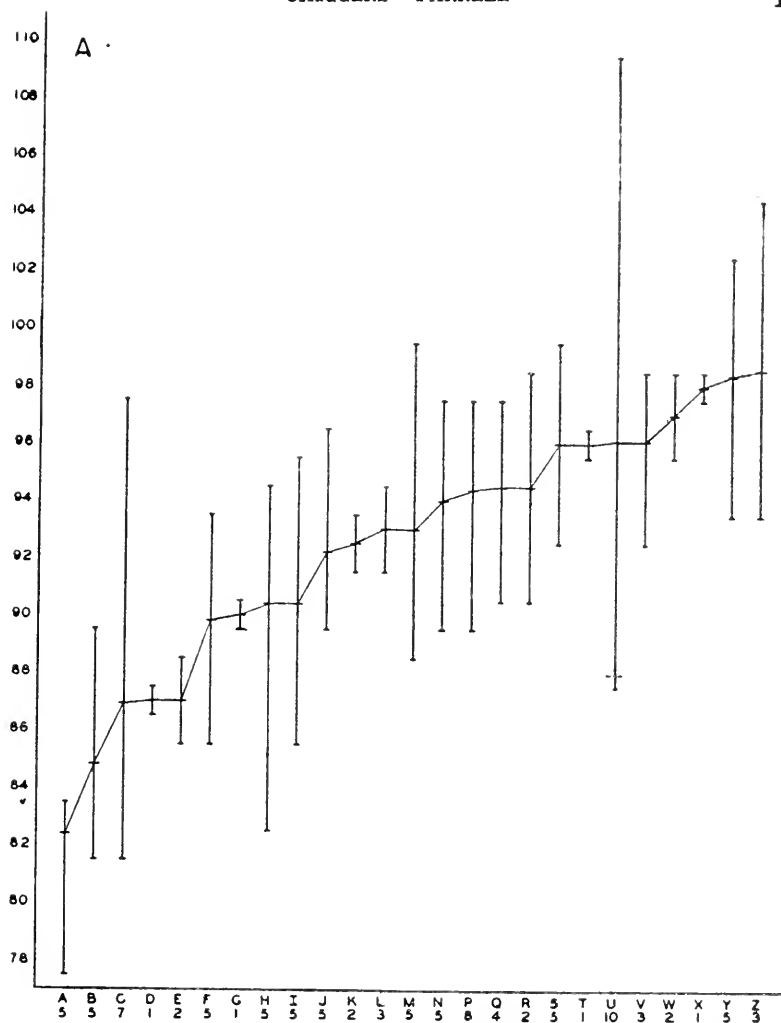


FIGURE 5.—For explanation see facing page.

The population peak coincided generally with the season of least rainfall (fig. 6,f) and highest soil moisture (fig. 6,g).

Laboratory experiments showed the rate of locomotion of *E. peromysci* to be influenced by temperature (fig. 6,h). The rate declined with falling temperatures until locomotion ceased at 0° C. As temperature rose, locomotion was resumed; the first

#### EXPLANATION OF FIGURE 6

- a, Distribution of setules on the galeal seta of chiggers in the "rubra" group. Vertical axis represents frequency; horizontal axis, number of setules per seta; light solid line, *Euschöngastia rubra*; light broken line, *E. magna*; heavy solid line, *E. diversa acuta*; heavy broken line, *E. diversa diversa*.
- b, Distribution of setules on the lateral seta of the palpal tibia of chiggers in the "rubra" group. Vertical axis represents frequency; horizontal axis, number of setules per seta; heavy broken line, *Euschöngastia diversa diversa*; heavy solid line, *E. diversa acuta*; light broken line, *E. magna*.
- c, Seasonal distribution of *Euschöngastia peromysci* in 91 collections of *Peromyscus leucopus* in the Duke Forest area, September 1947 to December 1949. The 91 collections included 392 specimens of *P. leucopus*. Horizontal axis represents months of the year, with the total number of collections of *P. leucopus* per month; vertical axis, percentage of collections positive for *E. peromysci*.
- d, Seasonal distribution of *Euschöngastia rubra* in 91 collections of *Peromyscus leucopus* in the Duke Forest area, September 1947 to December 1949. The 91 collections included 392 specimens of *P. leucopus*. Vertical axis represents percentage of collections positive for *E. rubra*; horizontal axis, months of the year, with the total number of collections of *P. leucopus* per month.
- e, Mean monthly temperatures in Duke Forest area, September 1947 to March 1950. Vertical axis represents temperature in degrees centigrade; horizontal axis, months of the year; light broken line, air temperature; light solid line, surface soil temperature; heavy solid line, subsurface temperature at three inches depth.
- f, Mean monthly precipitation in Duke Forest area from September 1947 to March 1950. Vertical axis represents inches of precipitation; horizontal axis, months of the year; light line, mean monthly precipitation in inches (yearly average for period, 44.33 inches); heavy line, mean monthly precipitation for central North Carolina for the 61-year period from 1887 to 1947 (yearly average for period, 46.76 inches).
- g, Monthly soil moisture in Duke Forest locality typical of areas in which hosts of *Euschöngastia peromysci* were trapped for the present study. Vertical axis represents soil moisture as a percentage of dry weight; horizontal axis, months of the year; light broken line, percentage of soil moisture in the A<sub>1</sub> horizon, 0 to 2 inches depth; light solid line, percentage of soil moisture in the A<sub>2</sub> horizon, 5 to 7 inches depth; heavy solid line, percentage of soil moisture in the B<sub>2</sub> horizon, 14 to 16 inches depth. The bar diagram gives the monthly rainfall in inches. The graph of soil moisture and the rainfall record covers the period from May 28, 1946, to March 16, 1947. There are no soil moisture records for December 1946 and no rainfall records for May 1946. Data obtained from the thesis of Mr. John B. Sharp, Jr., in the School of Forestry, Duke University, 1947.
- h, Behavior of *E. peromysci* and *T. alfreddugèsi* during falling and rising temperatures. Vertical axis represents rate of locomotion in millimeters per second; horizontal axis, temperature in degrees centigrade; light line, rate of locomotion of *E. peromysci*; heavy line, of *T. alfreddugèsi*. Rates above .80 mm. per second for *T. alfreddugèsi* have been omitted. Calculations by Dr. G. W. Wharton.

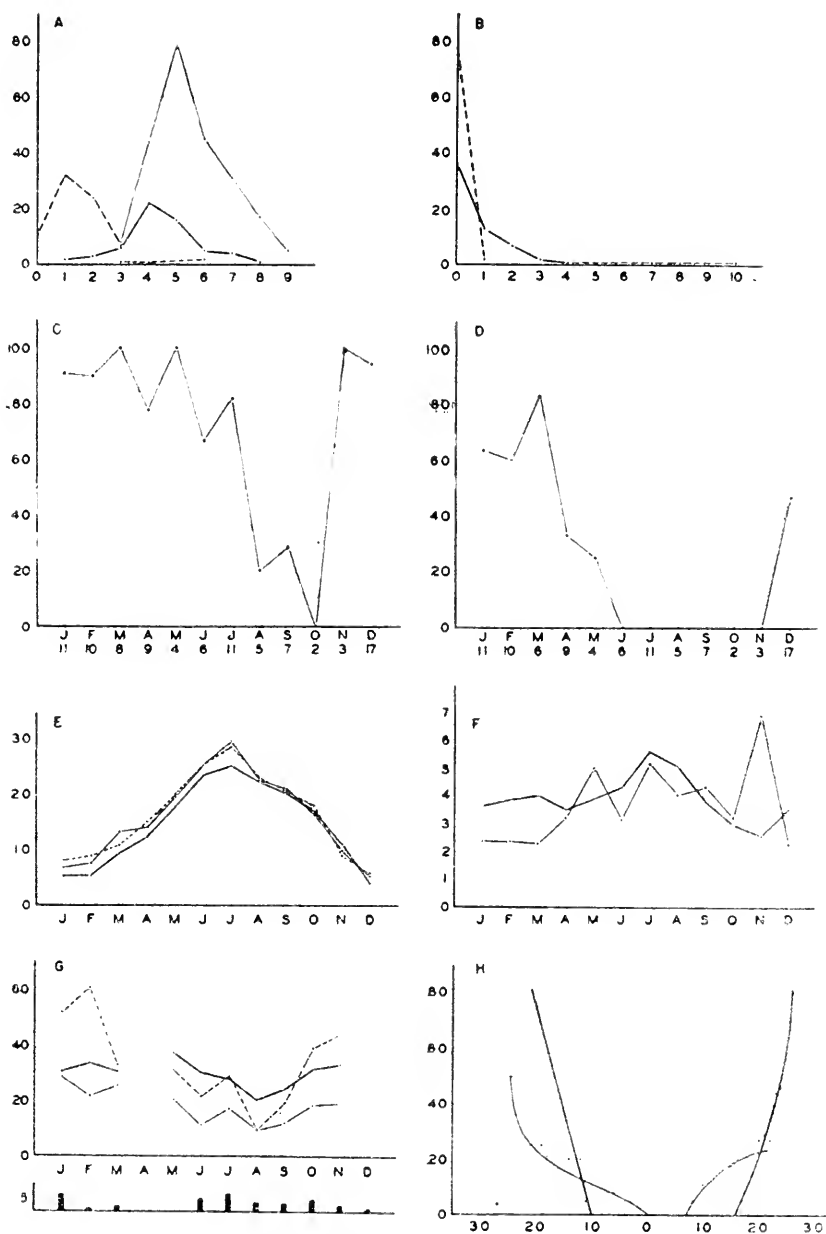


FIGURE 6.—For explanation see facing page.

record was obtained at 7° C. The rate increased with continued rise in temperature. *Trombicula alfreddugèsi*, a chigger with a warm weather distribution, showed a more rapid decline in rate of locomotion with falling temperature and ceased locomotion at 10° C. With rising temperature, *T. alfreddugèsi* resumed locomotion at 16° C.; and its rate rose rapidly as temperature increased.

*E. peromysci* chiggers were recovered alive from an infested *Peromyscus leucopus* host which had been kept frozen at -4.5° C. for 38 days.

*E. peromysci* was found attached deep in the ear or in the external auditory meatus of its hosts. After death of the host, the chiggers detached and wandered over the ear (pl. 3) and fur of the host.

DISCUSSION OF ECOLOGY: From the evidence assembled, there could be a correlation between temperature, soil moisture conditions, and the seasonal population peak of *E. peromysci* on hosts. During the colder months when most plant growth has ceased, soil moisture is at its highest. The combination of low temperature and high moisture content of the soil should produce in the soil the most humid conditions of the year. During these months, *E. peromysci* had its greatest incidence on hosts in the Duke Forest area. This conforms with the results of Pearse (1946), who found populations of microfauna in Duke Forest generally to be highest during the colder, moister season.

That there is a correlation between the physiology of *E. peromysci* and its seasonal occurrence is indicated in a comparison of the temperatures at which it and the warm weather *T. alfreddugèsi* ceased locomotion under experimental conditions. The same correlation is evident in the temperatures at which locomotion was resumed. In both phases of the experiment *E. peromysci* carried on activity at much lower temperatures. Experimental evidence showed also that *E. peromysci* can withstand freezing temperatures for extended periods. However, the occasional occurrence of *E. peromysci* in the summer indicates that temperature alone is not the critical factor in its seasonal distribution.

The temperature at which *T. alfreddugèsi* stopped locomotion corresponds well with the findings of Jenkins (1948). In his experiments *T. alfreddugèsi* was not active below 9.5° C. at 60 percent relative humidity. Various authors have indicated the seasonal occurrence of different chiggers. Ewing (1921) pointed out the seasonal distribution of *T. alfreddugèsi*. Audy (1947a)



showed a correlation between seasonal rains and seasonal abundance of *T. deliensis* at Imphal. No literature has been found on physical factors limiting species of *Euschöngastia*.

**CULTURES:** Sixty-eight cultures of *E. peromysci* were established. Usually cultures were started with nymphs which readily metamorphosed from engorged chiggers held in special plaster-charcoal lined vials. In culture the nymphs lived for varying periods of time, but in general the history of the cultures was uniform. The nymphs steadily declined in activity and died. No later developmental stage was obtained.

Of the variety of culture containers tried, the most satisfactory were made with the bottom intact and a layer of plaster-charcoal poured in. Jars and bottles with bottoms removed and the openings plugged with plaster-charcoal were difficult to make and awkward to use. It was necessary to place them in finger bowls to catch the moisture which escaped through the plaster-charcoal. Jars lined with moist cellulose wadding were unsatisfactory. Nymphs in them soon became immobile. Cultures in jars lined completely with plaster-charcoal were more difficult to examine than those in unlined jars, although nymphs lived well in them. Odd containers used for special purposes were difficult to manage and to observe and gave no promise of being better for the mites than more convenient sizes and shapes. Several sorts of containers were useful. The shallow weighing bottles with openings the full diameter of the bottles permitted unobstructed examination with the dissecting microscope. They were used extensively in feeding trials. However, active mites were sometimes crushed between the long, tapered, ground-glass sealing surfaces. Small, 4-ounce, wide-mouth jars were satisfactory, but control of moisture was more difficult with them than with larger containers. The wide-mouth pint jar seemed best adapted for general use. The chief disadvantage of this jar lay in its being too deep for observation with the dissecting microscope. This difficulty was removed when the layer of plaster-charcoal was made sufficiently thick. Also, the extra absorbent material made control of moisture less critical. Solid metal lids and screw bands regularly supplied with the jars were found to be the most satisfactory covers for the cultures. Wide-mouth pint jars about one-third filled with plaster-charcoal and fitted with the solid lids made compact and useful units.

Nymphs were placed in culture jars without adding a material through which they could move when experiments to find an acceptable food were being carried out. When given the opportunity, the mites would quickly enter soil or any loose medium

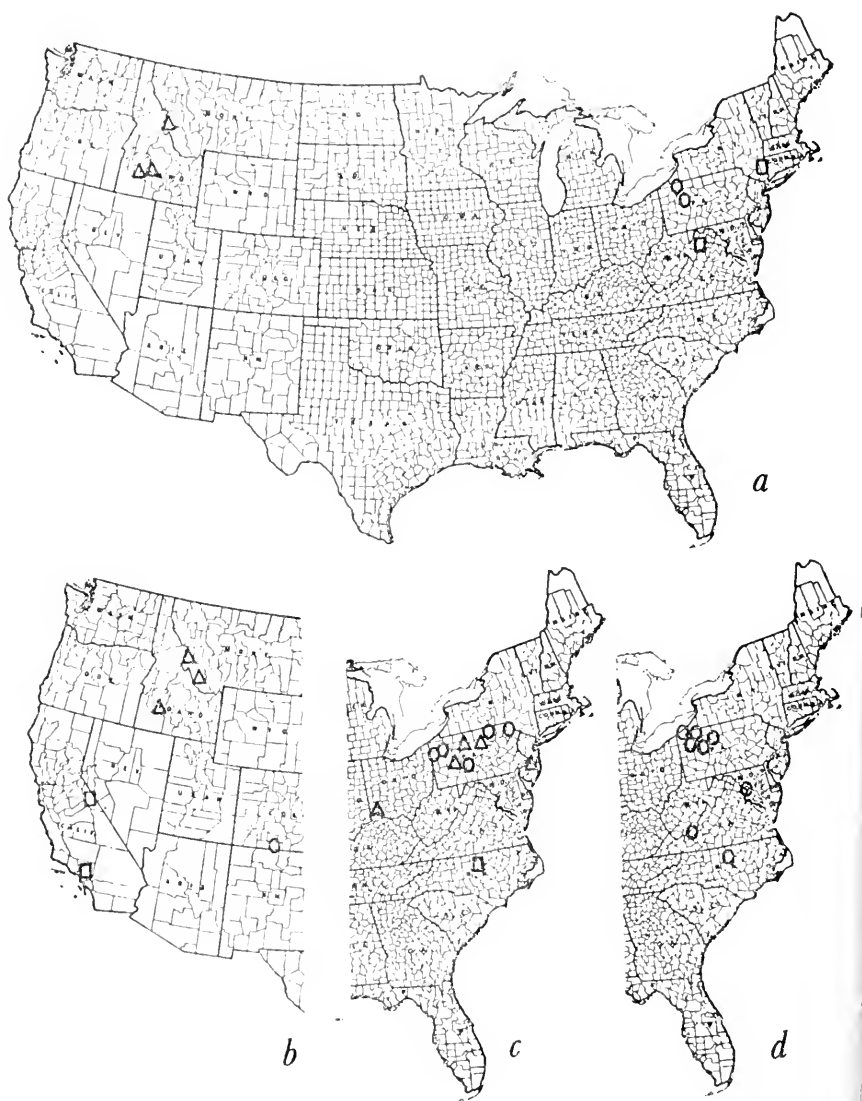


FIGURE 7.—Maps showing: a, distribution of *E. luteodema*,  $\Delta$ ; *E. marmota*,  $\circ$ ; and *E. hamiltoni*,  $\square$ . b, Distribution of *E. californica*,  $\square$ ; *E. criniticollis*,  $\Delta$ ; and *E. guntheri*,  $\circ$ . c, Distribution of *E. carolinensis*,  $\square$ ; *E. crateris*,  $\circ$ ; and *E. chioensis*,  $\Delta$ . d, Distribution of *E. blairinae*,  $\circ$ .

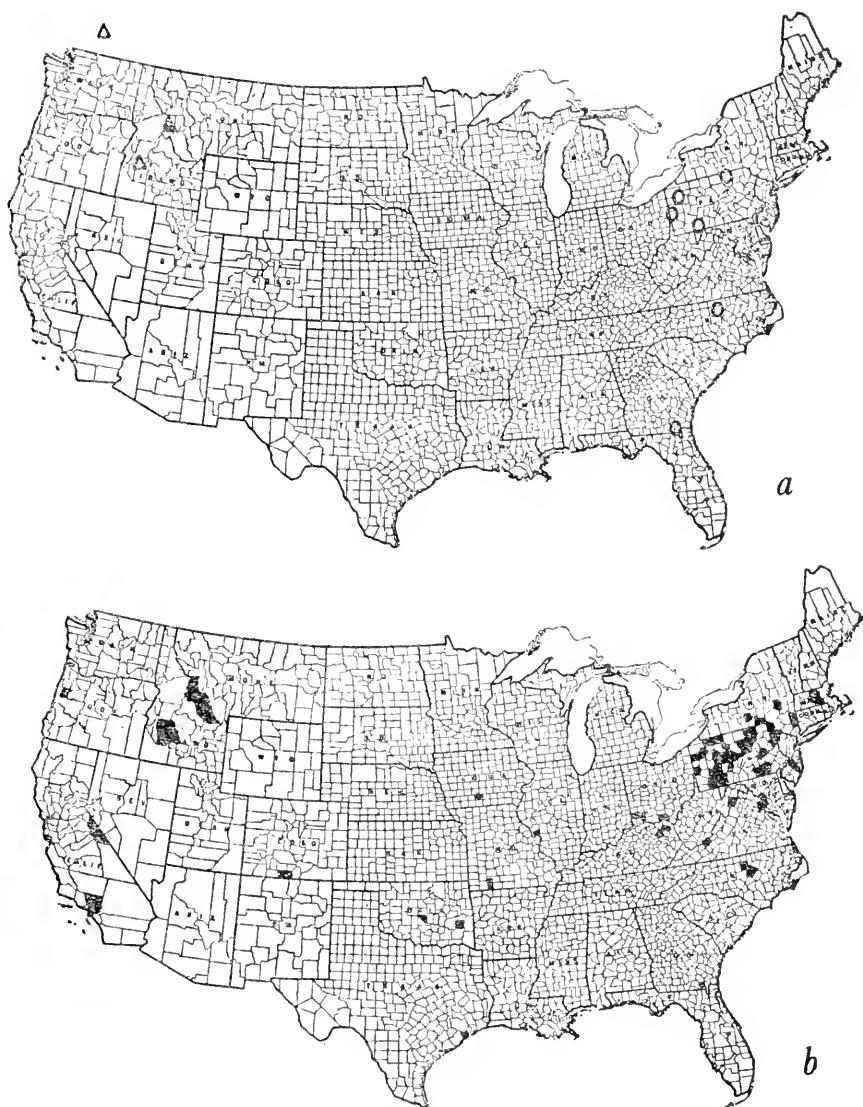


FIGURE 8.—Maps showing: *a*, Distribution of *E. sciuricola*,  $\triangle$  and  $\blacktriangle$ ; *E. setosa*,  $\circ$ ; and *Euschingastia* sp.,  $\blacktriangle$ . One record of *E. sciuricola* in British Columbia, Canada. *b*, Distribution of the genus *Euschingastia*, based on known collections, in the United States. The Canadian locality and that of the Mexican species are not shown. Each county in the United States from which a collection has been recorded is shown in black. The Okefenokee Swamp location is indicated by a dot—county not known.

placed in the jars. Usually some medium was added. Soil, the various soil mixtures, humus, and organic debris had certain disadvantages. Frequently the surfaces became covered with fungus. The nymphs often entered these media and were never seen again. Such media were difficult and unsatisfactory to move for examining the cultures. Vermiculite was the most satisfactory medium. It formed a soft, loose stratum through which the mites could move easily. It could be rolled about easily for examining the culture without damaging the mites. Apterous insects, sometimes kept in cultures, survived and multiplied in vermiculite. Nymphs seemed to survive better in vermiculite than in other media.

Fungus frequently developed in cultures but never became a serious problem. When cultures were carefully moistened and excess water avoided, fungus was retarded. Its control with vermiculite was easier than with other media. Rolling vermiculite in the culture jar broke up mycelia and reduced growth. With both soil and vermiculite, adding *Onychiurus* sp. to cultures was usually effective in controlling fungus. These small, apterous insects fed on the fungus. Apparently they were not harmful to chiggers or nymphs.

Cultures maintained at 30° C. seemed to follow the same pattern as those held at room temperature. Nymphs steadily died out. Nymphs held at 5° to 10° C. were very sluggish in their movements when examined, but they moved more rapidly after being at room temperature for a few minutes. Room temperature seemed more satisfactory than other temperature ranges tried. Cultures, excepting those held at definite temperatures, were kept in a darkened cabinet.

Evidence is not adequate to determine whether a proper food for nymphs of *E. peromysci* was found. So far as was determined by direct observation, the nymphs rejected almost all food offered. *Aedes aegypti* eggs were offered regularly to most cultures. Under observation *E. peromysci* nymphs appeared to try to feed on these eggs on only one occasion. On the day one culture was established, two nymphs were observed manipulating eggs. Body contractions and expansions, typical of feeding nymphal or adult trombiculids, occurred. The efforts ceased in a few minutes. Examination of one of the eggs showed no openings or any other evidence of successful feeding by the nymph. Four successful acts of feeding on freshly dissected *Aedes aegypti* ovaries and eggs were observed. The first nymph to feed stopped at a scratch mark made by the needle in the plaster-charcoal base in placing

a dissected ovary in the culture. Later the nymph located the ovary and fed for 15 to 20 minutes. It changed its position twice during feeding. Flowing movements were observed in the fluid mass of the ovary immediately in front of the nymph's gnathosoma. Bubbles or fluid materials of varying densities were observed moving posteriorly through the middle of the gnathosoma. Observations on the other three acts were similar, but in two of these the mass of the ovary was pushed up to a nymph pattering in the region of a needle scratch. On one other occasion a nymph inserted its gnathosoma into the mass of a dissected ovary and remained in position for about a minute. No signs of feeding could be determined. It disengaged its gnathosoma and lay on its side while seeming to clean its appendages. On a number of other occasions nymphs ignored dissected *Aedes* ovaries.

One culture was established with two nymphs obtained from larvae engorged on a white mouse in the laboratory. Vermiculite was used as a medium through which the mites could move. *Sinella curviseta*, a collembolan, was maintained in this culture. These insects laid eggs and reproduced. When the culture was flooded 163 days after it had been established, one plump, living nymph was recovered. It can be inferred that this nymph fed on some stage of *Sinella curviseta*. This record of 163 days represents also the longest time a nymph was kept alive.

As indicated in the preceding paragraph, *E. peromysci* larvae engorged successfully on white mice in the laboratory. The unengorged larvae were obtained from forest soil materials by means of Berlese funnels. One such experiment was used as a start to obtain information concerning the time involved in various stages of the life cycle. Numerous wild-caught, unengorged larvae were placed on a white mouse. One engorged chigger was obtained on the fourth day and seven engorged chiggers on the seventh day after exposure. These eight chiggers were preserved. On the eighth day after exposure of the mouse to the larvae, 15 engorged chiggers were recovered. These were placed in a special vial. Four days later these chiggers were immobile, entering the nymphochrysalis stage. Nine days after this stage had been reached, one nymph was found in the vial. On the 11th day after the immobility of the larvae, the vial contained nine nymphs. No other nymphs or nymphochrysalids were found. These nymphs were held in the special vial without addition of any food. Thirty-six days later the vial contained one dead and eight living nymphs.

It was demonstrated, also, that *E. peromysci* would attach to man. Fifteen unattached, unengorged *E. peromysci* larvae were

obtained from forest soil materials through Berlese funnels. These were distributed in seven cells which were then attached to the palmar surfaces of a man's forearms. When the applications were examined  $4\frac{1}{2}$  to 7 hours later, two chiggers were missing from the cells. Of the chiggers found in the cells, nine were dead and four were alive. One of the living chiggers, examined  $5\frac{1}{2}$  hours after application, was attached to the skin. It was fastened securely in the center of a small reddish spot about 2 mm. in diameter. Apparently it was attached at a pore, not at the base of a hair. When first observed, it was wet with water or perspiration; all legs projected sharply posteriorly and it did not move. Nudged repeatedly with a dissecting needle, it was thrust about, pivoting on its gnathosoma. In a short time it began to move its legs in the air. Several trials were made with a dissecting needle before the chigger was removed from the point of attachment and preserved. All other chiggers also were preserved.

REMARKS: The known range of *E. peromysci* gives it the widest distribution of any North American *Euschöngastia*. It varies within limits through its range. Certain variations, which have been charted, seem to have geographical continuity. The frequency with which it has been collected indicates *E. peromysci* is the most common *Euschöngastia* to be found on small mammals east of the Mississippi River.

Examinations of the holotype of *E. peromysci* (Ewing, 1929) and of the cotypes of *E. signator* (Ewing, 1931) and *E. brevipes* (Ewing, 1931) showed all three species to conform to the same morphological pattern. The ranges of *E. peromysci* and *E. brevipes* have been united by subsequent collections. Collections have not yet united this eastern range with that of *E. signator*, but the newer records from Ohio, Kentucky, and North Carolina point toward the continuity. Certain morphological characters of *E. signator* do appear at the limits of variation of the species, so that a possibility of subspeciation remains. However, on the basis of morphology and geographical distribution, the three species are here considered to be the same and *E. brevipes* and *E. signator* to be synonyms of *E. peromysci*.

#### 9. *Euschöngastia cordiremus* Brennan

FIGURE 4,a; PLATES 6, 12

*Euschöngastia cordiremus* Brennan, 1948, pp. 465, 470, 471, 477, figs. 5,a-d, 11.

DESCRIPTION: Size: Length engorged, 410 to 580; width, 225 to 350.

Shape: Long ovoid or oval.

Color: Yellow (Brennan, 1948).

Gnathosoma: Seta on palpal femur strong, curved, well covered with strong setules on convex curvature. Genua seta thinner, with a few long, slender setules alternately arranged. Dorsal seta on palpal tibia slender with few, slender, alternate setules; lateral seta slender with one to three slender setules; ventral seta with setules spaced alternately in two dorsal rows. Palpal claw strong, slightly curved, three-pronged, the two smaller accessories arising together on the basal half. Galeal seta rather small with two or three setules. Chelicera typical; base heavy; blade smoothly curved with small subapical dorsal tooth and a larger ventral tooth. Punctae on palpal coxa and cheliceral base.

Legs: Leg I with two slender genualae and a microgenuala, two tibialae with a microtibiala, a rather small spur with microspur about half the length of the spur distal, a subterminala, a parasubterminala, and a pretarsala. Leg II with a single slender genuala, two shorter tibialae, a rather long, slender spur with microspur near the base, usually anterior, and a pretarsala. Leg III with a slender genuala and a slender tibiala. Nonspecialized setae generally with setules shorter and finer than in *E. peromysci*. All leg segments punctate.

Scutum: Shape generally similar to that of *E. peromysci* but more fully rounded. Setae well covered with short setules, but less densely than in *E. peromysci*. Pseudostigmata well behind a line between the posterolateral setae, deep and globular. Enlarged portion of sensilla ovoid or with tips truncate; well covered with setules on anterior surface, fewer on posterior surface; pedicel rather long, enlarging into the head. A strong ridge arises anteromedial to each pseudostigma, curving anteriorly, laterally, and posteriorly to the posterior margin of the scutum; the two ridges sometimes continuous medially. Surface punctate. Cuticular striae apparent over posterior margin.

Standard data of the five specimens studied from Ravalli County, Mont.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
49	61	13	25	23	8	25	28	45	32
47	57	13	22	25	12		25	46	30
48	58	13	18	26	13	25	25	48	
50	61	11	22	27	10	28	28	44	21*
50	61	13	19	26	14	27	32	48	32

\*Expanded portion only.

Eyes: Two pairs, anterior pair lateral to posterolateral setae. Diameter of anterior eyes, 10 to 11, mean 10.4; of posterior eyes, 9 to 11, mean 10.4.

Dorsal setae: Shafts of setae moderately heavy; rather short setules cover shaft well but not densely; anteriorly, the side adjacent to body is nude; posteriorly, setules distributed around the shaft; posteriors end bluntly or with V-clefts. Length of humerals, 43 to 50; of setae near the middle of the first post-humeral row, 38 to 44; of setae in the posterior group, 33 to 38.

Dorsal formulae of the five specimens studied from Ravalli County, Oreg.:

2	..	10	..	13	..	..	15	..	8	..	6	..	2	
2	..	10	..	13	..	..	11	..	8	..	8	..	7	
2	..	10	..	12	..	..	14	..	9	..	7	..	5	
2	..	10	..	12	..	..	12	..	8	..	6	..	5	
2	..	10	..	10	..	2	..	10	..	10	..	7	..	5

Ventral setae: Poststernals similar to dorsals. Number of first sternals, 2; of second sternals, 4; of poststernals, 57 to 71. Length of first sternals, 35 to 42; of second sternals, 25 to 32; of setae near the middle of the first poststernal row, 21 to 24; of setae in the posterior group, 32 to 42.

MATERIAL: Five paratypes studied. The four collected Oct. 16, 1945, are in the U. S. National Museum; the one collected Feb. 6, 1946, was borrowed from Rocky Mountain Laboratory. Specimens from hosts, all in Montana:

*Peromyscus m. artemisiae*

Ravalli County: Oct. 16, 1945, 4.

*Peromyscus*

Ravalli County: Feb. 6, 1946, 1.

SEASONAL DISTRIBUTION: Brennan (1948) reported collections in February, May, and October.

GEOGRAPHICAL DISTRIBUTION: *E. cordiremus* has been collected only in Ravalli County, Mont. (fig. 4,a).

DIAGNOSIS: *E. cordiremus* is the only species with four setae in the second sternal row. It is quite similar to *E. peromysci*. In *E. cordiremus* the enlarged portion of the sensilla is less sharply distinct from the pedicel than it is in *E. peromysci*. The galeal seta of *E. cordiremus* lacks the bristlelike appearance which characterizes the galeal seta of *E. peromysci*.

REMARKS: Advantage has been taken of the similarity of *E. cordiremus* to *E. peromysci* in the description of the former. The two might easily be considered to form a group.

### The "rubra" group

The "rubra" group, as it is now known, is composed of three new species, with one of these divided into two subspecies. Diagnostic features of the group include: Tibiala III present, two genualae I, subterminala and parasubterminala I present, papal claw with three prongs, galeal seta usually branched, two pairs



of distinct eyes, a scutum marked by three joined ridges, cuticular striae folded over the posterior margin of the scutum, and capitate sensillae. As the genus is known at the present time, the form of the ridges on the scutum is sufficient to set off the "*rubra*" group from other North American species, as follows: Two inverted, somewhat V-shaped ridges—one anterior to each pseudostigma—with a third ridge extending anteriorly around the anterior median seta connecting the apexes of the first two.

#### 10. *Euschöngastia rubra*, new species

FIGURES 4,b, 6,a,d; PLATES 2, 4, 7, 13

DESCRIPTION: Size: Length, 276 to 722; width, 165 to 554.

Shape: Ovoid in unengorged specimens in life, broader posteriorly, becoming oval with engorgement. Unengorged specimens preserved on slides, ovoid; engorged specimens preserved on slides, broadly oval.

Color: Light red in unengorged specimens, becoming pink, orange, and yellow with increasing engorgement; always with deep red eyes.

Gnathosoma: Seta on palpal coxa with strong fringe of setules on outer curvature. Strong, forward-curving seta on palpal femur

TABLE 7.—Distribution of setules on the galeal setae by pairs of setae for 121 specimens of *Euschöngastia rubra*

Number of setules	Frequency	Number of setules	Frequency	Number of setules	Frequency
3-4	2	5-5	15	6-8	3
3-5	3	5-6	11	6-9	1
3-6	1	5-7	6	7-7	3
3-x	2	5-8	2	7-8	6
4-4	4	5-9	1	7-x	4
4-5	21	5-x	5	8-8	1
4-6	8	6-6	8	8-9	3
4-7	4	6-7	5	8-x	1
4-x	1				

(Each figure is the number of setules on one seta of the pair; x indicates a seta broken off)

with numerous setules evenly distributed except on concave margin, which tends to be nude. Strong curving seta on palpal genu with numerous setules in about four alternate rows on its convex curvature. Dorsal seta on palpal tibia strong with setules in one or two rows on its outer curvature; lateral seta shorter, strongly pectinate or with setules alternately arranged on its outer curvature; ventral seta long and strong with numerous setules alternately arranged over the longitudinal dorsal half of the shaft. Palpal claw strong, curved, three-pronged with median prong longest and strongest; accessories strong, arising about one-half

the length of the claw from its base. Palpal tarsus typical, feathered setae with strong setules. Palpal coxa and femur punctate. Galeal seta strong, usually slightly curved inward, strongly pectinate with number of setules variable (table 7 and fig. 6,a) with five the central tendency. Basal segment of chelicera heavy, laterally angulate, strongly punctate; blade strong, curved, with distinct subapical dorsal and ventral teeth.

Legs: Leg I with two strong genualae of moderate length and a fine microgenuala; two typical tibialae with a fine microtibiala closely posterior to the more distal of the two; a strong spur slightly proximal to middle of the tarsus with microspur about half the length of the spur distal, single strong subterminala and parasubterminala, and typical pretarsala. Leg II with a strong genuala and two tibialae of moderate length; tarsus with long spur and proximal microspur, pretarsala typical. On leg III a single genuala and a single tibiala, both strong and of moderate length. Nonspecialized setae moderately long with numerous long, curving setules in alternate pattern forming a brush along the outer surfaces. Legs taper slightly. All leg segments with punctae.

Anomaly: On one specimen a spurlike striated seta in addition to the normal tibiala was located on the distal dorsal surface of one tibia III.

Scutum: Narrower between anterolateral setae, increasing slightly in width to posterolaterals, and broadly rounded posteriorly. Anterolateral corners extended, causing the anterior margin to be strongly incurved. Anterolateral and posterolateral setae approximately equal in length; anteromedian much shorter, set back from anterior margin, usually ascending from depression on scutum and bent sharply in mounting; setae with numerous slender setules, similar to dorsals, distributed around the shafts. Surface punctate and strongly marked with ridges and depressions. Usually with one or two slightly larger pits or pores posterolaterally. Anterior to each of the two pseudostigmata a V-shaped ridge, apex anterior; outer leg curved, extending past posterolateral seta and blending into posterior margin; medial leg almost straight. A third ridge extending anteriorly around the anterior median seta is continuous with the apexes of the first two. Pseudostigmata close together, posterior to a line drawn between the posterolaterals, set into the bases of the ridges near the ends of the medial legs. Sensillae capitate; heads distinctly set off from pedicels and covered by short setules; heads usually lie within the depressions behind the ridges. Cuticular striae over portion posterior to pseudostigmata.

In life, posterolateral setae project posteriorly at a slight angle to the body; anterolaterals project posterolaterally at a slight angle, converging medially; anteromedian seta projects almost perpendicularly from the scutum, giving it an anterior inclination caused by the somewhat anterior exposure of the scutum.

Anomalies: In each of two specimens a posterolateral seta together with its setal base was lacking.

Standard data of the type specimen from Orange County, N. C.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
48	62	19	17	35	10	63	37	61	30

Summary of standard data of 16 specimens, including the type, from Orange, Durham, and Wake Counties, N. C. (AL's from 15 specimens, AM's from 15 specimens, S's from 6 specimens):

AW 42-54, mean 48.5; PW 58-66, mean 61.9; AP 17-23, mean 20.5;  
 SB 11-20, mean 15.8; ASB 29-38, mean 33.8; PSB 10-14, mean 11.9;  
 AL 50-63, mean 59.9; AM 29-38, mean 33.9; PL 52-65, mean 59.3;  
 S 25-30, mean 25.8.

Eyes: Two pairs. Anterior eyes lateral to posterolateral setae, distance varying with engorgement. Anterior and posterior eyes almost contiguous in unengorged specimens, becoming separated with engorgement. Diameter of anterior eyes of 14 specimens, 11 to 13, mean 12.4; of posterior eyes 10 to 13, mean 11.6.

Anomaly: In one specimen no posterior eyes were apparent; on one side there were apparently two eyes transversely arranged.

Dorsal setae: Numerous setae in six posthumeral rows plus a few irregular posteriors. Longitudinal portion of seta opposite body densely covered with fine setules of moderate length; portion adjacent to body tends to be nude. Posterior setae terminate bluntly or with V-clefts, perhaps with fewer setules than the anteriors but of the same form. Length of humerals of 13 specimens, 54 to 61; of setae from the middle of the first posthumeral row, 50 to 55; of setae from the posterior group, 32 to 38.

Dorsal setal formulae of 10 specimens from North Carolina:

Orange County:	2 .. 12 .. 15 .. .. 15 .. .. 15 .. 9 .. 7 .. 4 (type)
	2 .. 13 .. 17 .. 1 .. 15 .. .. 14 .. 8 +14
	2 .. 12 .. 17 .. 1 .. 16 .. .. 14 .. 9 +10
	2 .. 13 .. 15 .. .. 15 .. .. 13 .. 9 +11
	2 .. 13 .. 15 .. 2 .. 17 .. 2 .. 12 .. 10 .. +9
Durham County:	2 .. 12 .. 17 .. .. 15 .. 1 .. 13 .. +16
	2 .. 14 .. 16 .. 2 .. 15 .. .. 13 .. 8 +12
	2 .. 12 .. 15 .. 2 .. 16 .. 3 .. 13 .. 8 +11
	2 .. 14 .. 16 .. .. 16 .. 2 .. 14 .. 10 .. +6
Wake County:	2 .. 12 .. 16 .. 2 .. 12 .. 1 .. 11 .. 9 .. +7

Ventral setae: Form of poststernals similar to that of dorsals. Data from 13 specimens: Number of first sternals, 2; of second

sternals, 2; of poststernals, 75 to 93. Length of first sternals, 53 to 61; of second sternals, 35 to 40; of setae near the middle of the first poststernal row, 28 to 33; of setae in the posterior group, 32 to 41.

Anomaly: Three setae in the second row of sternals on a single specimen.

MATERIAL: Type, USNM 1991. Specimens from hosts and unattached, all from North Carolina:

*Peromyscus leucopus*

Orange County: Dec. 1947, DU-3;  
Jan. 1948, DU-4; Mar. 1948,  
DU-1; Apr. 1948, DU-3; Dec.  
1948, DU-3; Jan. 1949, DU-6,  
Apr-1, Aus-1, CEF-10; Feb.  
1949, DU-10, CEF-7; Mar. 1949,  
DU-12; Apr. 1949, DU-1; May  
1949, DU-1.

Durham County: Dec. 1947, DU-1;  
Jan. 1948, DU-2; Feb. 1948,  
DU-5; Dec. 1948, DU-18, RML-5,  
CM-3, KU-3; Jan. 1949, DU-8;  
Feb. 1949, DU-3; Mar. 1949,  
USNM-2, DU-3; Apr. 1949,  
DU-4.

Wake County: Feb. 1948, DU-6.

Surface soil

Durham County: Feb. 1948, DU-1;  
Apr. 1948, USNM-1.

*Peromyscus nuttalli*

Wake County: Feb. 1948, DU-1;  
Mar. 1948, DU-3.

Under old stump

Orange County: Dec. 1948, DU-1.

*Sylvilagus floridanus mallurus*

Orange County: Feb. 1949, CEF-2.

Base of hollow tree

Orange County: Mar. 1949,  
USNM-1.

Under decaying stumps

Orange County: Mar. 1949, DU-1;  
Jan. 1950, USNM-Type +1,  
DU-3.

Soil (19 to 30 cm, depth?)

Orange County: Jan. 1950,  
USNM-4.

SEASONAL DISTRIBUTION: All collections of *E. rubra* were made during the months of December through May (fig. 6,d). Dates of first and last collections of each season:

Season	First collection	Last collection
1947-1948	Dec. 25, 1947	Apr. 25, 1948
1948-1949	Dec. 12, 1948	May 1, 1949
1949-1950	Jan. 7, 1950	- - -

GEOGRAPHIC DISTRIBUTION: *Euschöngastia rubra* has been collected only in Durham, Orange, and Wake Counties, N. C. (fig. 4,b).

DIAGNOSIS: *Euschöngastia rubra* can be distinguished from the other species of its group by the strongly branched lateral seta on the palpal tibia, by the different shape of its scutum with its smaller size and stronger ridges and depressions, and by its more southern range.

ECOLOGY: In the Duke Forest area the ecology of *E. rubra* appears to be similar to that of *E. peromysci*. Both species of chiggers commonly occurred on the same host specimens. How-

ever, *E. rubra* was confined strictly to the season during which soils were colder and more moist (fig. 6,d).

*E. rubra* was found attached deep in the ears or in the external auditory meatus of its hosts.

**CULTURES:** Seven cultures were started with *E. rubra* nymphs. These were in weighing bottles or wide-mouth pint jars. One weighing bottle was lined with moist cellulose wadding. On this the nymphs soon became immobile and all were dead in less than 13 days. Other weighing bottles and the jars had a base of plaster-charcoal. No medium for the mites was used in one culture. In other cultures soil or vermiculite in combination with other materials was used. *Aedes* eggs or soil arthropods were offered as food. In no culture was there any further development. Engorged larvae from hosts readily metamorphosed into nymphs in special vials. But nymphs in culture apparently refused all food offered and soon died.

**LIFE HISTORY:** A very limited amount of life history information was obtained from the culture data. It was found that nymphs can develop from engorged larvae in 15 days or less. One living nymph was recovered from a culture which had been established with four nymphs 29 days earlier.

**REMARKS:** The type specimen of *E. rubra* is an unattached, unengorged specimen collected from the debris under a small, decayed removable stump (pl. 2). *E. rubra* has been named from the color of unengorged specimens.

#### 11. *Euschöngastia magna*, new species

FIGURES 4,b, 6,a,b; PLATES 7, 13

**DESCRIPTION:** Size: Engorged length, 630 to 660; width, 370 to 475.

Shape: Broad oval.

Gnathosoma: General similarity to *E. rubra*. Lateral setae on palpal tibiae with four and eight setules on one specimen, seven and ten on the second specimen (fig. 6, b). Palpal claw similar to that of *E. rubra* but straighter, longer, and stouter. Tarsal spur longer than in *E. rubra*. Galeal setae with four and six setules on one specimen, three and six on the second specimen (fig. 6,a).

Legs: Similar to *E. rubra*.

Scutum: General outline much like that of *E. rubra*, about the same proportionate taper between anterolaterals and posterolaterals, rounded posteriorly. About one-fifth larger over-all than *E. rubra*; largest scutum in the group. Ridges and depressions less strong than in *E. rubra*.

Standard data for the two specimens from Union County, Pa.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
62	78	24	22	38	14	70	43	69	35 (Type)
59	76	24	19	35	15	67	40	67	25*

\*Head of sensilla only.

Eyes: Two pairs; diameters of both pairs, 12 to 13.

Dorsal setae: Similar in form to those of *E. rubra*; anterior and posterior setae of the same form. Total number greater than in *E. rubra*, chiefly because of two extra rows of setae. The extra rows are shown in italic in the dorsal formulae. Length of humerals, 61 to 63; of setae near the middle of the first post-humeral row, 50 to 55; of setae in the posterior group, 41 to 43.

Dorsal formulae for the two specimens from Union County, Pa.:

2 .. 15 ..	6 .. 17 ..	8 .. 13 ..	3 .. 11 ..	10 +10 ..	..	(Type)
2 .. 14 ..	6 .. 18 ..	11 .. 14 ..	.. 9 ..	9 .. 7 ..	2 .. 2	

Ventral setae: Poststernals similar to those of *E. rubra*; number of first sternals, 2; of second sternals, 2; of poststernals, 107. Length of first sternals, 58 to 67; of second sternals, 40 to 41; of setae near the middle of the first poststernal row, 34; of setae in the posterior group, 38 to 43.

MATERIAL: Type, USNM 1992. Specimens from hosts, all from Pennsylvania:

*Neotoma magister*

Union County: May 16, 1949,  
USNM-Type.

*Clethrionomys g. gapperi*

Union County: May 24, 1949,  
DU-1.

GEOGRAPHIC DISTRIBUTION: *E. magna* has been collected only in Union County, Pa. (fig. 4,b).

DIAGNOSIS: *E. magna* can be distinguished from the other species in the group by the larger size of its scutum and the extra rows of setae in the dorsal formula.

REMARKS: The type specimen of *E. magna* was found in association with *E. peromysci* and *E. diversa diversa* on *Neotoma magister*. *E. magna* has been named for the larger size of the scutum.

## 12. *Euschöngastia diversa*, new species

*Euschöngastia diversa* is a northern form, divided into two subspecies. Morphologically it differs from the more southern *E. rubra* by a general reduction in the number of setules on the setae of the gnathosoma, fewer body setae which differ in form on the anterior and posterior portions of the body, and a somewhat larger scutum which tends to be rectangular in general outline.

In the study of the "*rubra*" group, at first all forms were placed together. It later became apparent that these specimens from the north were different from those collected in Duke Forest. From this "difference" their name is derived.

12a. *Euschöngastia diversa diversa*, new subspecies

FIGURES 4,b, 5,c, 6,a,b; PLATES 7, 14

DESCRIPTION: Size: Length, 290 to 635; width, 185 to 430.

Shape: Ovoid to broad oval.

Color: As in *E. rubra*.

Gnathosoma: General form as in *E. rubra*; fewer setules on all setae. Seta on palpal genu with about two to twelve setules in one or two rows on convex curvature. Lateral seta on palpal tibia

TABLE 8.—Distribution of setules on the lateral seta of the palpal tibia by the pair of setae per specimen for 40 specimens of *E. diversa diversa*.

Number of setules	Frequency
0-0	36
0-1	2
0-x	1
x-x	1

(Each figure is the number of setules on one seta of the pair; x indicates a seta broken off)

usually nude (table 8 and fig. 6,b). Palpal claw similar to that of *E. rubra*; two accessory prongs arising on proximal half, clearly interrupting the smooth contour of the claw. Galeal seta with reduced number of setules, usually one or two (table 9, and fig. 6,a). Chelicera similar to that of *E. rubra*.

Anomaly: One specimen with four prongs on one palpal claw.

Legs: Generally similar to *E. rubra*.

Scutum: Generally somewhat wider and shorter than in *E. rubra*. Less taper between anterolaterals and posterolaterals than in *E. rubra*; width between anterolaterals proportionately greater.

TABLE 9.—Distribution of setules on the galeal seta by the pair of setae per specimen for 40 specimens of *E. diversa diversa*.

Number of setules	Frequency	Number of setules	Frequency	Number of setules	Frequency
0-0	2	1-2	9	2-3	5
0-1	5	1-3	1	2-x	1
0-2	1	1-x	1	3-x	1
0-x	1	2-2	4	x-x	1
1-1	8				

(Each figure is the number of setules on one seta of the pair; x indicates a seta broken off)

Posterior margin not so rounded as in *E. rubra*, tending to be straight or with a shallow concavity in the middle. The whole scutum appearing somewhat rectangular. Ridges and depressions not so marked as in *E. rubra*, appearing more flat. Apparently a tendency within the species for scutum to become larger from west to east (fig. 5,c).

Standard data of the type specimen from Clermont County, Ohio:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
60	67	19	19	35	11	64	39	64	23*

\*Head of sensilla only

Summary of standard data, including the type, of five specimens from each geographic region—Clark County, Iowa; Clermont County, Ohio; Scioto County, Ohio; and Union County, Pa. (AM's from 19 specimens, S's from 5 specimens):

AW 54-66, mean 58.1; PW 63-73, mean 67.2; AP 16-22, mean 18.5;  
 SB 16-22, mean 18.9; ASB 25-37, mean 33.3; PSB 10-14, mean 11.9;  
 AL 54-72, mean 65.6; AM 31-39, mean 35.6; PL 54-70, mean 61.6;  
 S 26-31, mean 29.4.

Eyes: Two pairs, subequal in size. Diameters (from 14 specimens) of anterior eyes, 10 to 13, mean 11.9; of posterior eyes, 9 to 13, mean 11.5.

Dorsal setae: Arranged in six or seven rather clearly defined transverse rows with a few irregularly placed on the posterior; total number fewer than in *E. rubra*. Form of setae over most of the body similar to *E. rubra*. Posterior setae with heavier shafts; setules shorter, heavier, somewhat scalelike, reduced in numbers and exposing portions of the shaft; free ends blunt or with V-clefts. Length of humerals, 54 to 64; of setae near the middle of the first posthumeral row, 50 to 63; of posterior setae, 41 to 56.

Dorsal formulae for five specimens from each geographical region:

Clarke County, Iowa:	2	..	14	..	15	..	..	15	..	..	10	..	10	..	6	..	+8	
	2	..	14	..	16	..	..	14	..	..	9	..	9	..	8	..	4	
	2	..	12	..	15	..	..	13	..	..	9	..	9	..	.	+7		
	2	..	14	..	14	..	..	15	..	..	11	..	10	..	7	..	3	
	2	..	14	..	14	..	..	15	..	..	9	..	8	..	8	..	+5	
Clermont County, Ohio:	2	..	12	..	13	..	..	12	..	..	11	..	7	..	.	+8 (Type)		
	2	..	12	..	17	..	..	12	..	..	10	..	10	..	5	..	..	
	2	..	13	..	14	..	..	15	..	..	12	..	.	..	.	+16		
	2	..	12	..	14	..	..	13	..	..	12	..	8	..	.	+7		
	2	..	13	..	14	..	..	14	..	..	11	..	11	..	6	..	4	
Scioto County, Ohio:	2	..	12	..	14	..	..	13	..	..	11	..	8	..	.	+7		
	2	..	12	..	14	..	..	12	..	..	10	..	7	..	7	..	7	
	2	..	12	..	15	..	..	13	..	..	9	..	8	..	9	..	4	
	2	..	14	..	14	..	..	14	..	..	10	..	11	..	9	..	6	
	2	..	12	..	16	..	..	12	..	..	12	..	10	..	6	..	1	
Union County, Pa.:	2	..	12	..	16	..	..	14	..	1	..	10	..	8	..	6	..	1
	2	..	12	..	15	..	..	12	..	..	9	..	8	..	.	+9		
	2	..	13	..	18	..	1	..	13	..	..	9	..	7	..	6	..	5
	2	..	13	..	?	..	..	?	..	..	?	..	?	..	?	..	?	
	2	..	12	..	17	..	..	14	..	..	?	..	?	..	?	..	?	
	? indicates setae could not be counted.																	

? indicates setae could not be counted.



Ventral setae: Form and arrangement similar to *E. rubra* except for posteriors which have fewer, shorter, scalelike setules. Total number fewer than in *E. rubra*. Data from 19 specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 62 to 80. Length of first sternals, 39 to 60; of second sternals, 30 to 45; of setae from the middle of the first row of poststernals, 28 to 35; of posterior setae, 42 to 59.

MATERIAL: Type, USNM 1993. Specimens from hosts:

Field mouse	<i>Microtus ochrogaster ohionensis</i>
Iowa	Ohio
Clarke County: Mar. 18, 1936, USNM-6.	Scioto County: Mar. 10, 1949, USNM-3, DU-5, CEF-1.
<i>Microtus p. pennsylvanicus</i>	<i>Clethrionomys g. gapperi</i>
Ohio	Pennsylvania
Clermont County: Mar. 15, 1948, KU-1.	Union County: May 15, 1949, CEF-1; May 27, 1949, RML-2; May 27-28, 1949, DU-1.
<i>Synaptomys cooperi saturatus</i>	<i>Neotoma magister</i>
Ohio	Pennsylvania
Clermont County: Mar. 15, 1948, USNM-Type, DU-2, CEF-1.	Union County: May 16, 1949, DU-2.
<i>Microtus ochrogaster</i>	
Ohio	
Clermont County: Jan. 3, 1949, DU-3, Afr-1, Aus-1; Jan 4, 1949, Du-4, CEF-1, CM-2; Jan. 16, 1949, DU-2.	

SEASONAL DISTRIBUTION: *E. diversa diversa* has been collected only during the winter and spring months, January, March, and May.

GEOGRAPHIC DISTRIBUTION: The known range of *E. diversa diversa*, as it is here defined, extends in a band from Clarke County, Iowa, in the west, through Clermont and Scioto Counties, Ohio, to Union County, Pa., in the east (fig. 4,b).

DIAGNOSIS: *Euschöngastia diversa diversa* can be distinguished from other members of the *E. rubra* group by the following combination of characters: Nude lateral seta on palpal tibia, reduced number of setules on the galeal seta, the form of the palpal claw which branches in the proximal half with accessory prongs interrupting the contour, and by its geographical range.

ECOLOGY: Mr. Woodrow Goodpaster supplied information concerning the Ohio collections.

The *Synaptomys* from which *E. diversa diversa* was collected in Clermont County, Ohio, was trapped in a meadow of timothy, bluegrass, blackberry, goldenrod, and sweet clover. Small elms and locust were present in the meadow. The *Microtus* were taken in the same locality or in rolling timothy-clover meadows. In

Scioto County, Ohio, the hosts were trapped in timothy meadows invaded by dewberry, blackberry, greenbriar, sumack, and locust. In all situations the soil was clay-loam and the ground was wet with winter rains. Hosts were trapped in runways on the surface.

The Scioto County collections were made from two specimens of *Microtus* which had been kept frozen very hard by the collector for five and seven days before the chiggers were removed. The chiggers were alive when removed.

Collectors recorded that *E. diversa diversa* infested the ears of the hosts.

**12b. *Euschöngastia diversa acuta*, new subspecies**

FIGURES 4,b, 6,a,b; PLATES 4, 7, 14

DESCRIPTION: Size: Length, 270 to 675; width, 170 to 430.

Shape: Ovoid to oval.

Color: As in *E. rubra*.

Gnathosoma: Tendency to fewer setules on palpal setae than in *E. rubra*, but not so much reduced as in *E. diversa diversa*. Seta on palpal genu with 8 to 20 or more setules in two or three

TABLE 10.—Distribution of setules on lateral seta of the palpal tibia by the pair of setae per specimen for 31 specimens of *E. diversa acuta*

Number of setules	Frequency	Number of setules	Frequency	Number of setules	Frequency
0-0	13	1-1	1	2-2	1
0-1	7	1-2	3	2-3	1
0-2	1	1-x	1	3-4	1
0-x	2				

(Each figure is the number of setules on one seta of the pair; x indicates a missing seta)

rows on the outer curvature. Lateral seta on palpal tibia usually nude (table 10; fig. 6,b), but not to the degree found in *E. diversa diversa*; setules frequently tiny. Palpal claw longer and smoother than in both *E. rubra* and *E. diversa diversa*; the two accessory

TABLE 11.—Distribution of setules on the galeal setae by the pair of setae per specimen for 31 specimens of *E. diversa acuta*

Number of setules	Frequency	Number of setules	Frequency	Number of setules	Frequency
1-4	2	3-7	1	5-5	3
2-4	2	4-4	3	5-6	1
2-x	1	4-5	6	5-7	2
3-3	1	4-6	2	6-8	1
3-4	2	4-7	1	6-x	1
3-5	1	4-x	1		

(Each figure is the number of setules on one seta of the pair; x indicates a missing seta)

prongs arise on distal half and usually lie close, interrupting the taper very little. Galeal seta with fewer setules (table 11; fig. 6,a) than in *E. rubra* but more than in *E. diversa diversa*; tendency to four or five setules.

Legs: Form of legs and form and distribution of all setae as in *E. diversa diversa*.

Anomalies: Distal tibiala I on one leg of a single specimen replaced by a microtibiala. The tibiala III lacking on one leg of a single specimen.

Scutum: With the characters of the group and similar to *E. diversa diversa* with the tendency to squareness at the postero-lateral corners somewhat more pronounced.

Standard data of the type specimen from Warren County, Pa.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
58	67	19	19	31	11	52	33	63	28

Summary of standard data, including the type, of ten specimens, five from each of Clearfield and Warren Counties, Pa. (AM's from nine specimens, S's from four):

AW 55-67, mean 59.6, PW 63-73, mean 68.8, AP 17-22, mean 19.1, SB 16-23, mean 20.1, ASB 31-36, mean 32.9, PSB 8-11, mean 9.9, AL 52-72, mean 61.7, AM 27-38, mean 33.4, PL 57-69, mean 62.4, S 28-32, mean 30.3.

Eyes: Two pairs. Anterior pair lateral to posterolateral setae. Diameter of anterior eyes of eight specimens, 10 to 13, mean 12; of posterior eyes, 10 to 13, mean 12.2.

Dorsal setae: Form, number, and arrangement similar to *E. diversa diversa*. Length of humeral setae of ten specimens, 54 to 62; of setae near the middle of the first posthumeral row, 50 to 55; of posterior setae, 38 to 47.

Dorsal formulae for five specimens from each geographic region:

Clearfield County, Pa.:	2 .. 12 .. 14 .. 12 .. 10 .. 8 .. 6 .. 2	
	2 .. 12 .. 11 .. 13 .. 11 .. 9 .. 7 .. 3	
	2 .. 13 .. 13 .. 13 .. 13 .. 9 .. 7 .. 3	
	2 .. 13 .. 12 .. 14 .. 9 .. 8 ..	+5
	2 .. 12 .. 14 .. 12 .. 10 .. 9 ..	+6
Warren County, Pa.:	2 .. 12 .. 13 .. 12 .. 10 .. 8 .. 2 ..	(Type)
	2 .. 12 .. 16 .. 12 .. 11 .. 10 ..	+7
	2 .. 12 .. 12 .. 12 .. 9 .. 9 .. 4 .. 2	
	2 .. 12 .. 13 .. 14 .. 8 .. 8 ..	+6
	2 .. 12 .. 14 .. 14 .. 10 .. 9 ..	+6

Ventral setae: Form, number, and arrangement similar to *E. diversa diversa*. Data from 10 specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 44+ to 72. Length of first sternals, 47 to 58; of second sternals, 33 to 40; of setae near the middle of the first poststernal row, 27 to 33; of posterior setae, 38 to 45.

MATERIAL: Type, USNM 1994. Specimens from hosts, all from Pennsylvania:

*Zapus h. hudsonius*

Warren County: June 17, 1948,  
DU-1, CEF-3; June 18, 1948,  
USNM-Type+5, DU-1.

*Microtus p. pennsylvanicus*

Clearfield County: Apr. 16, 1949,  
CEF-1; Apr. 24, 1949, CEF-3.

*Synaptomys cooperi stonei*

Clearfield County: Apr. 22, 1949,  
CEF-1.

*Napcozapus i. insignis*

Clearfield County: May 4, 1949,  
DU-4, RML-2, CM-2; May 5,  
1949, DU-5, KU-1, Afr-1, Aus-1.

SEASONAL DISTRIBUTION: *E. diversa acuta* has been collected only during the spring months, April, May, and June.

GEOGRAPHIC DISTRIBUTION: *E. diversa acuta* has been collected in two counties, Clearfield and Warren, in northwestern Pennsylvania (fig. 4,b).

DIAGNOSIS: *E. diversa acuta* can be distinguished from other members of the *E. rubra* group by the form of its palpal claw, the reduced number of setules on the lateral seta of the palpal tibia, the relatively high number of setules on the galeal seta, and by its geographic range.

ECOLOGY: According to Mr. Neil Richmond, the hosts in Warren County, Pa., were collected in a hay meadow and in the surrounding thickets of blackberry, elm, hawthorn, and pin cherry. The area was located on a flat, well-drained floodplain of the Allegheny River. The summer season was well advanced. Over 100 *Microtus* and 70 to 80 *Peromyscus*, as well as *Blarina*, *Condylyura*, and *Tamiasciurus*, were trapped with few or no chiggers.

The chiggers were attached deep in the pinna on *Zapus* and to the scalp below and behind the pinna.

CULTURES: Two cultures of *E. diversa acuta* nymphs were established. One culture was in a pint jar with the bottom removed and the opening plugged with plaster-charcoal. In the second a base of plaster-charcoal was poured into the intact jar. Forest soil was used as a medium in both. *Aedes aegypti* eggs were offered as food in both. No further development of the nymphs occurred.

LIFE HISTORY: From collection dates and culture records it was determined that engorged larvae of *E. diversa acuta* metamorphosed into nymphs in 12 days or less. One living nymph was observed in a culture 29 days after the culture had been established.

REMARKS: *E. diversa acuta* has been named from the form of its palpal claw.

The forms comprising the "*rubra*" group are obviously related. They are bound together by their morphology, their seasonal distribution, and their geographic range. However, variations occur within the pattern of the group, and the morphological differences are correlated with geographic distribution so that the separate

forms become apparent. Morphologically the group is split in two by the shape of the scutum and the form and number of the body setae. The split is emphasized by the variation in the number of setules on the galeal setae (fig. 6,a) and the lateral seta on the palpal tibiae (fig. 6,b). Thus, *E. rubra* and *E. magna* go together and are distinctly set off from *E. diversa*. Evidence that this cleavage represents a real difference at the specific level and not a geographical variation at the subspecific level is obtained in the collections from Union County, Pa. Here the ranges of the morphologically distinct *E. diversa* and *E. magna* coincide.

The collections from Union County are meager; and, since they are pivotal in determining the number of species in the "*rubra*" group, some consideration should be taken concerning the possibility that the two forms are variants of the same species. Of the eight specimens from Union County, six have been placed in *E. diversa* and two in *E. magna*. The *E. diversa* specimens represent four collections of two host species. The *E. magna* specimens represent two collections of the same two host species. Both forms were taken once from the same host animal. Although the sampling of the chigger population is small, it is well dispersed; and it seems unlikely that a minor group of genetic variants would comprise as much as 25 percent of such a sample. The occurrence of both forms on a single host is evidence that they are not ecophenotypes. The morphological distinctness of the two forms with the absence of intergrades indicates they are not variants.

Within the basic pattern of *E. diversa* two populations are separable geographically. The known geographic ranges of the two populations are separated by only one county in Pennsylvania. Based on the combination of morphology and range, the best explanation of the relationship between the two populations seems to be that they are geographic races of the same species. Two subspecies have been erected for them in *E. diversa*.

The relationship between those forms here named *E. rubra* and *E. magna* is by no means clear. The difference in size of scuta is not great when the geography is considered. However, at the present time the two forms can be separated by the size of the scutum. The extra rows of dorsal setae in the northern form separate it from the southern form. There are no collections between North Carolina and Union County, Pa., to indicate trends of variations or extent of ranges. Future collections may show that the two forms are distinct or that they fall within the limits of a single species. In the present state of knowledge of the genus it seems best to recognize forms that are clearly separable. In this

way they add to the total picture and make possible more rapid progress.

The "*rubra*" group is unique in the genus for variability in a relatively small geographic area. Further collections, particularly from the region of Union County, Pa., and the areas between the known geographic ranges, are needed to define the systematics of the species more sharply. Also, with so variable a group it is probable that other related forms will be discovered in areas not yet investigated.

13. *Euschöngastia guntheri* (Radford)

FIGURE 7,b; PLATES 6, 15

*Neoschöngastia guntheri* Radford, 1942, pp. 76, 77, fig. 101; 1947a, pp. 596-598, figs. 23, 24; 1947b, p. 275.

*Euschöngastia guntheri*, Brennan, 1948, vol. 34, p. 473.—Fuller, 1952, pp. 182, 183.

DESCRIPTION: Size: Length of the single specimen studied, 400; width, 335.

Shape: Broad oval.

Gnathosoma: Long curving seta on palpal femur with sparse, rather long setules alternately arranged. Seta on palpal genu shorter, curved, with a few long setules in rows on its outer curvature. Dorsal seta on the palpal tibia long, arching, with a row of setules; lateral seta thin with two fine setules. Palpal claw long and smooth; three prongs, median prong longest. Galeal setae with four and seven long setules, respectively. Cheliceral base heavy, longer than broad; blade strong, curved; subapical dorsal and ventral teeth distinct. Palpal coxa and femur and base of chelicera punctate.

Legs: Leg I with two genualae and a microgenuala, two tibialae and a microtibiala, a typical spur, a microspur, a subterminala, a parasubterminala, and a pretarsala; all striated setae rather short. Leg II with a single genuala, two tibialae, a spur with proximal microspur, and a pretarsala; spur long, the others rather short. Leg III with one rather small genuala; no tibiala. Nonspecialized setae on leg I rather long on proximal segments beyond the trochanter, shorter distally, with numerous short curving setules on the surfaces opposite the leg. On leg II, dorsally particularly, setae tend to have fewer, straighter setules. Both sorts of nonspecialized setae on leg III. Two setae on coxa III. Leg segments stout. Claws on tarsi I and II small in proportion to the size of the tarsi. All leg segments with punctae.

Anomaly: One coxa I with two setae.

Scutum: Twice as broad as long. Pointed at the posterolateral corners. Anterior margin approximately straight with antero-

lateral corners extended slightly anteriorly and a median convexity adjacent to the anteromedian seta. Lateral margins concave, diverging posteriorly. Posterior margin with a slight concavity just medial to each posterolateral corner and broadly convex posteriorly. Anterolateral setae and posterolateral setae on the extensions at the corners; anteromedian seta close to the anterior margin. Setae rather heavy. Pseudostigmata moderately separated, considerably posterior to a line drawn between the posterolaterals. Sensillae clavate; pedicel distinct; expanded portion pyriform; setules on anterior surface of head smoother, those on posterior surface fewer and more offstanding. Anterior to each pseudostigma a long crescentic ridge. Punctae rather widely spaced. Two larger pits or pores about halfway between the posterolateral and the pseudostigma visible on one side.

Standard data of the single specimen studied from Antonito, Colo.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
71	103	21	32	34	13	34	36	64	34

Eyes: Two pairs lateral to the posterolateral corners. Diameter of anterior eyes, 12; of posteriors, 11.

Dorsal setae: Rather heavy; well clothed with rather short setules; the same form throughout; numerous; tend to occur in bands rather than in rows. Length of a humeral, 57; of a seta from the middle of the first posthumeral row, 54; of one from the posterior group, 36.

Dorsal formula of the single specimen from Antonito, Colo.:

$$2 \dots 12 \dots 12 \dots +26 \dots +27 \dots +15 \dots +14$$

Ventral setae: Form similar to that of the dorsals. Number of first sternals, 2; of second sternals, 2; of poststernals, about 100. Length of a first sternal, 54; of a second sternal, 44; of a seta near the middle of the first poststernal row, 32; of a seta from the posterior group, 38.

MATERIAL: Borrowed from the Rocky Mountain Laboratory. Specimen from host:

*Ochotona* sp.

Antonito, Colo., Sept. 9, 1931, 1.

DIAGNOSIS: *E. guntheri* is the only species in the genus which characteristically has two setae on coxa III.

#### 14. *Euschöngastia criceticola* Brennan

FIGURE 7, b; PLATES 7, 15

*Euschöngastia criceticola* Brennan, 1948, pp. 465, 473-474, 476, 477, figs. 6, 13.

DESCRIPTION: Size: Length, 400 to 455; width, 245 to 285.

Shape: Ovoid.

Color: Yellow (Brennan, 1948).

Gnathosoma: Seta on palpal femur strong, curved, moderately clothed with setules. Seta on genu smaller, pectinate. Dorsal seta on tibia pectinate; lateral seta on tibia slender, with one or two slender setules, or nude; ventral seta slender, with about three alternate rows of setules on the dorsal side of the shaft. Palpal claw curved, with three prongs, median prong longest. One specimen with five prongs on the palpal claw. Galeal seta with several setules. Cheliceral base typical; blade strong, curved, subapical dorsal and ventral teeth distinct. Palpal coxa punctate; base of chelicera indistinctly punctate.

Legs: Leg I with two genualae, a microgenuala, two tibialae, a microtibiala, a middorsal spur and a distal microspur, a subterminala, a parasubterminala, and a pretarsala, all rather short. Leg II with a genuala and two tibialae, all very short; spur long with microspur anterior to it; pretarsala of normal size. Leg III with a very small genuala; no tibiala. Nonspecialized setae on leg I generally with a fringe of short, curved setules; nonspecialized setae on legs II and III mostly with fewer and straighter setules. All coxae punctate; some distal segments punctate.

Anomaly: Both subterminalae I and both parasubterminalae I lacking in one specimen.

Scutum: Over twice as wide as long. Anterior margin slightly concave between anteromedian seta and anterolaterals. Lateral margins concave, diverging posteriorly. Posterior margin convex posterior to pseudostigmata, usually slightly concave between them; exact outline somewhat obscured by cuticular striae. Anteromedian seta close to the anterior margin. Setae rather short, covered with short setules. Pseudostigmata a moderate distance apart; posterior to a line drawn between the posterolateral setae; deep, in marked depressions under the medial margins of strong horseshoe-shaped ridges. Sensillae long clavate; each enlarging from the base without distinct pedicel; widest about four-fifths the length from the base; covered by setules which extend down to the pseudostigma; setules longer and smoother on the anterior surface. Surface of scutum with punctae, usually most apparent in medial region, usually one or two larger pits or pores near ridge medial to posterolateral setae. Cuticular striae encroach upon the posterior margin and appear to cross the anterolateral corners posterior to the anterolateral setae.

Summary of standard data of four specimens from Beaverhead County, Mont. (AM's from two specimens, S's from three):



AW 59-63, mean 61.3; PW 79-82, mean 80.5; AP 15-19, mean 17; SB 21-27, mean 24.8; ASB 22-22, mean 22; PSB 13-16, mean 13.8; AL 32-41, mean 36.3; AM 29-31, mean 30; PL 44-46, mean 45.3; S 31-35, mean 32.7. Width of head of sensilla in two specimens, 14 and 16.

Eyes: Two pairs lateral to the posterolateral setae. Diameter of anteriors, 10 to 13, mean 12; of posteriors, 10 to 12, mean 10.7.

Dorsal setae: Uniformly covered with short setules on side opposite body, any on edges closer to body appear heavier; all setae of the same general pattern. Length of humerals, 48 to 57; of setae near the middle of the first posthumeral row, 42 to 48; of setae in the posterior group, 32 to 34.

Dorsal formulae for four specimens from Beaverhead County, Mont.:

2	..	13	..	13	..	14	..	10	..	5	..	4	..	4
2	..	12	..	14	..	13	..	9	..	6	..	4	..	
2	..	12	..	14	..	12	..	8	..	6	..	4	..	
2	..	13	..	13	..	13	..	9	..	8	..	3	..	

Ventral setae: Poststernals generally similar to dorsals in form. Number of first sternals, 2; of second sternals, 2; of poststernals, 41 to 54. Length of first sternals, 42 to 48; of second sternals, 28 to 35; of setae near the middle of the first poststernal row, 25 to 32; of setae in the posterior group, 30 to 32.

MATERIAL: Two of the paratypes in the Rocky Mountain Laboratory, the other two in the U. S. National Museum. Specimens from host:

#### *Peromyscus*

Beaverhead County, Mont., Sept. 3, 1945, 4.

SEASONAL DISTRIBUTION: Brennan (1948) reported collections in February, June, and September.

GEOGRAPHIC DISTRIBUTION: Brennan (1948) lists collections from Ravalli and Beaverhead Counties, Mont., and from Elmore County, Idaho (fig. 7,b).

DIAGNOSIS: *E. criceticola* can be distinguished by the following combination of characters: No tibiala III; palpal claw usually with three prongs; scutum with two strong, horseshoe-shaped ridges, each inclosing a pseudostigma in a deep depression; and a thin lateral seta, nude or with one or two thin setules, on the palpal tibia. *E. criceticola* is quite similar morphologically to *E. californica*. On *E. criceticola* the lateral seta on the palpal tibia is slender with one or two thin setules or nude. This seta is strongly branched on *E. californica*. The character of the non-specialized leg setae differs in the two species. The nonspecialized

setae on leg I of *E. criceticola* bear a fringe of short curved setules. These setules of *E. californica* are stronger and much longer.

REMARKS: The occurrence of one specimen with five prongs on the palpal claw among the four paratypes studied might indicate that this feature is quite variable. However, the same specimen was anomalous in lacking the subterminala and parasubterminala I on both legs. Brennan (1948) lists nine specimens in the type series and states the palpal claw is rarely with more than three prongs. In eastern species with a three-pronged palpal claw the character is very constant. To determine whether a five-pronged palpal claw represents normal variability or anomaly within *E. criceticola*, further collections and study are required.

### 15. *Euschöngastia californica* (Ewing)

FIGURE 7,b; PLATES 8, 16

*Schöngastia californica* Ewing, 1925b, pp. 261, 262.

*Neoschöngastia californica*, Ewing, 1931, p. 5.—Radford, 1942, p. 72.—Sig

Thor and Willmann, 1947, pp. 310, 312–313.

*Euschöngastia californica*, Fuller, 1948, p. 108; 1952, p. 183.

DESCRIPTION: Size: Length of the single specimen studied, 420; width, 225.

Shape: Long oval.

Gnathosoma: Seta on palpal femur strong, curved, with long setules on outer curvature. Seta on palpal genu strong, curved, with three or four rows of long setules. Dorsal seta on palpal tibia with two alternate rows of setules; lateral seta with six long setules; ventral seta with long setules. Palpal claw with three strong prongs; median prong longest and strongest; accessories arise about a third the length of the claw from its base. Galeal seta with five setules, most projecting dorsally. Chelicera with typical base, only the subapical ventral tooth determinable. No punctae discernible.

Legs: Leg I with two genualae and a microgenuala, two tibialae and a microtibiala, a rather long spur with distal microspur, a subterminala, a parasubterminala, and a pretarsala. Leg II with a genuala, two tibialae, a long, rather slender spur with microspur proximal and slightly anterior, and a pretarsala. Leg III with a genuala. Nonspecialized setae generally long with long, curving setules. No punctae seen.

Scutum: Anterior margin slightly concave between antero-median seta and each anterolateral. Lateral margins short, concave, diverging posteriorly. Posterior margin deeply convex. All setae close to the margin; anterolaterals and posterolaterals

on slightly extended corners; anteromedian on an anterior convexity. Setae well covered with setules. Pseudostigmata well behind a line drawn connecting posterolaterals; deeply set. Sensillae with expanded, cordiform heads well covered with setules on the anterior surface, sparsely covered on the posterior surface. A ridge apparent anterior to each pseudostigma, the sensilla lying in a depression behind it. No punctae seen.

Standard data of the single specimen from Los Angeles, Calif. (expanded portion of sensilla only measured):

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
47	60	14	20	27	12	50	32	44	20

Eyes: Two pairs, prominent; anterior pair lateral to the posterolateral setae. Diameters of both anterior and posterior eyes, 12.

Dorsal setae: Nude adjacent to body. Setules rather short. Free ends blunt or V-cleft. Length of humeral, 40; of a seta near the middle of the first posthumeral row, 38; of a seta from the posterior group, 34.

Dorsal formula of the single specimen from Los Angeles County, Calif.:

2 .. 12 .. 10 .. 2 .. 10 .. 2 .. 9 .. 6 .. 4

Ventral setae: Free ends of anterior setae fine, becoming heavier and more blunt posteriorly. Number of first sternals, 2; of second sternals, 2; of poststernals, about 48. Length of a first sternal, 44; of a second sternal, 29; of a seta near the middle of the first poststernal row, 20; of a seta in the posterior group, 33.

MATERIAL: All specimens in the U. S. National Museum. Specimens from hosts:

Ground squirrel

Topaz, Calif., 4.

*Neotoma* sp.

Los Angeles County, Calif., Jan. 13,

1933, 1.

DIAGNOSIS: *E. californica* closely resembles *E. criceticola*, from which it can be distinguished by the more strongly branched lateral seta on the palpal tibia and by the different character of the nonspecialized leg setae. In *E. criceticola* the tendency for the body setae to terminate bluntly is less marked. In *E. californica* the expanded portion of the sensilla is shorter and there is less taper into the pedicel than in *E. criceticola*.

REMARKS: In the specimen upon which this redescription has been based, the number of nonspecialized setae on the palpal tarsus could not be determined.

Ewing's original description of *Euschöngastia californica* was

made from four specimens collected from a ground squirrel at Topaz, Mono County, Calif. It is a description of a species that could be included in *Euschöngastia*, as the genus is known. Probably the description is not adequate to identify any species today. The type specimens (USNM 893) cannot be deciphered by the methods now in use.

The specimen described here was collected from *Neotoma* sp. in Los Angeles County, Calif. So far as can be determined, its morphology is consistent with the original description. It was identified by Ewing as *E. californica*. No useful function can be attained by permitting names to lapse into questionable status when there is reasonable evidence that they apply to specimens at hand. The name *E. californica* is available. There is evidence that the specimen being considered here is conspecific with the type material. The name *E. californica* is here applied to this specimen, which is made the basis for a redescription of the species. This specimen, in the U. S. National Museum, is on the slide marked "C. E. F. X."

#### The "*luteodema*" group

The "*luteodema*" group is composed of two species, *E. luteodema* and *E. marmotae*. The group is distinguished by the following combination of characters: No tibiala III, palpal claw with three prongs, a single seta on coxa III, nonspecialized setae on the legs with rather few and heavy, straight setules. The scutum is wide and relatively flat; any ridges are weak. The sensillae are clavate on distinct pedicels. The palpal setae have a reduced number of setules. Dorsal setae have relatively few and heavy setules. There is a tendency for the dorsal setae of the first three posthumeral rows to occur out of line, or in bands rather than in rows.

#### 16. *Euschöngastia luteodema* Brennan

FIGURE 7,a; PLATES 7, 17

*Euschöngastia luteodema* Brennan, 1948, pp. 470, 472-473, figs. 5A-B, 12.

DESCRIPTION: Size: Engorged length, 370 to 610; width, 300 to 640.

Shape: Broad oval, sometimes broader than long.

Color: Pale yellow (Brennan, 1948).

Gnathosoma: Seta on palpal coxa with few setules. Seta on palpal femur strong, with a few strong setules. Seta on genu with about three to seven setules. Dorsal seta on tibia with about three to six setules; lateral seta nude; ventral seta with about

five long setules. Palpal claw strong; three-pronged; median prong longest and heaviest; prongs arise near middle or on distal half. Galeal seta nude or with one, two, or three setules. Chelicera large; distinct subapical dorsal and ventral teeth on blade. Palpal coxa and cheliceral base usually without apparent punctae, occasionally with very small, faint punctae.

Legs: Leg I with two slender genualae and a microgenuala, two tibialae, the more proximal longer, and a microtibiala, a rather small spur and a distal microspur, a subterminala, a parasubterminala, and a pretarsala. Leg II with two rather small tibialae, a slender spur with proximal microspur, and a pretarsala. No genuala II. Leg III with no specialized setae. Non-specialized setae with few setules. Empodium long. Usually no punctae apparent, occasionally fine and faint on coxae.

Anomaly: One specimen with two setae on one coxa III.

Scutum: Shape somewhat variable, about twice as wide as long. Anterior margin convex between anteromedian seta and the anterolaterals. Lateral margin straight or slightly concave, diverging posteriorly. Posterior margin convex; or convex posterior to the pseudostigmata and slightly concave between them; or made up of three rather straight lines joined by short curves near the pseudostigmata. Posterolateral corners somewhat pointed. The five setae set close to margin; setae rather heavy with relatively few setules. Pseudostigmata posterior to a line drawn between the posterolateral setae. Sensilla long clavate, but with distinct pedicel, widest about four-fifths the length from the base; distal end rounded or slightly pointed; covered with setules on the anterior surface, setules fewer and shorter on posterior surface. Usually without ridges anterior to pseudostigmata; two specimens with ridges suggested. No punctae apparent. Usually with two or three small pits on each side between the posterolateral seta and the pseudostigma.

Summary of standard data of five specimens, three from Ravalli County, Mont., and two from Camas County, Idaho (AM's from four specimens, S's from three):

AW 60-70, mean 64.6; PW 84-102, mean 92.2; AP 16-25, mean 20;  
SB 29-42, mean 32.8; ASB 24-33, mean 29.2; PSB 10-13, mean 12;  
AL 39-48, mean 42.8; AM 38-43, mean 39.8; PL 58-62, mean 60.2;  
S 34-44, mean 40. Width of head of sensilla in three specimens, 14, 15, and 16.

Eyes: Two pairs lateral to the posterolateral setae. Diameter of anterior pair, 11 to 13; of posterior pair, 9 to 12.

Dorsal setae: Rather heavy with relatively few heavy setules.

Setae numerous, tend to occur in bands rather than in rows anteriorly. Length of humerals, 50 to 67; of setae near the middle of the first posthumeral row, 41 to 56; of setae in the posterior group, 33 to 49.

Dorsal formulae for five specimens:

Montana

Ravalli County:	2	..	21	..	22	..	10	..	8	..	5	..	4
	2	..	19	..	16	..	13	..	7	..	4	..	?
	2	..	19	..	17	..	11	..	8	..	8	..	6

Idaho

Camas County:	2	..	17	..	17	..	13	..	7	..	6	..	
	2	..	21	..	19	..	11	..	3	..	12	..	7 .. 6 .. 4

Ventral setae: Sternals with finer setules, other ventral setae similar in form to dorsals. Data from five specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 40 to 50. Length of anterior sternals, 41 to 51; of second sternals, 32 to 41; of setae in the middle of the first poststernal row, 28 to 38; of setae from the posterior group, 33 to 49.

Anomaly: Two specimens with three first sternals.

MATERIAL: All paratypes. The two specimens from *Tamiasciurus* in the Rocky Mountain Laboratory; all other specimens in the U. S. National Museum. Specimens from hosts:

*Marmota*

Montana

Ravalli County: May 17, 1945,  
4; July 30, 1945, 4.

Idaho

Camas County: June 30, 1945, 2.

*Tamiasciurus*

Montana

Ravalli County: Mar. 27, 1946, 2.

SEASONAL DISTRIBUTION: Brennan (1948) reported collections during the months of March, April, May, June, and July.

GEOGRAPHIC DISTRIBUTION: Brennan (1948) listed collections from Ravalli County, Mont., and Camas and Elmore Counties, Idaho (fig. 7,a).

DIAGNOSIS: *E. luteodema* is the only North American species which lacks specialized setae on the genu II, the genu III, and the tibia III.

17. *Euschöngastia marmotae*, new species

FIGURE 7,a; PLATES 7, 16

DESCRIPTION: Size: Engorged length, 430 to 660; width, 340 to 615.

Shape: Broad ovoid to broad oval.

Color: Orange.

Gnathosoma: Seta on palpal femur strong with relatively few setules on its convex curvature. Seta on palpal genu with few

setules, usually two to eight. Dorsal seta on palpal tibia with one or two rows of setules; lateral seta usually nude, two out of forty branched; ventral seta with few setules in two rows. Palpal claw strong with three prongs, median prong longest and strongest. Galeal seta usually with two setules (table 12). Base of chelicera heavy; blade smooth and curved with distinct subapical dorsal tooth and larger ventral tooth. Palpal coxa and base of chelicera punctate.

Anomaly: One specimen with four prongs on one palpal claw.

TABLE 12.—*Distribution of setules on the galeal setae of 18 specimens of E. marmotae*

Number of setules	Frequency	Number of setules	Frequency
0	1	3	6
1	4	4	1
2	19	?	5

(Question mark indicates undetermined number of setules)

Legs: Leg I with two slender genualae and a microgenuala, two tibialae and a microtibiala, a rather small spur with distal microspur, a subterminala, a parasubterminala, and a pretarsala. Leg II with a slender genuala, two slender tibialae, a rather small spur with proximal microspur, and a pretarsala. Leg III with a slender genuala. Nonspecialized leg setae with relatively few, straight setules. Punctae on coxae; fine punctae on distal segments not always visible. Claws and empodium long and strong.

Scutum: Large. Anterior margin slightly convex between anteromedian seta and posterolaterals. Lateral margins slightly convex, diverging posteriorly. Posterior margin somewhat paralleling anterior margin, convex posterior to pseudostigmata and concave between them. Posterolateral corners pointed, bearing posterolateral setae. Setae large and strong with relatively few setules, set close to margin. Pseudostigmata slightly behind a line drawn between the posterolaterals. Sensillae long, clavate, widest in distal third, free end rounded or with a heavy pointed setule; anterior surface well clothed with setules; setules few on posterior surface; pedicel distinct. A long, slight ridge anterior to each pseudostigma, beginning just anteromedial to the pseudostigma and running laterally and anteriorly, curving posteriorly near lateral margin; sometimes indistinct or absent. Punctae scattered. Usually two small pits between each posterolateral seta and the pseudostigma.

Standard data of the type specimen from Jefferson County, Pa.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
72	102	27	33	28	10	61	44	82	47 x 13

Summary of standard data from five specimens, including the type, from Jefferson County, Pa.:

AW 67-76, mean 71.2; PW 98-114, mean 106.2; AP 24-27, mean 25.6; SB 32-38, mean 35.4; ASB 28-31, mean 29.8; PSB 9-12, mean 10.6; AL 56-63, mean 58.8; AM 44-56, mean 47.8; PL 76-82, mean 80.8; S 40-47, mean 43.6. Width of head of sensilla, 13 to 15, mean 13.4.

Eyes: Two pairs; anterior pair lateral to posterolateral setae. Diameter of anterior pair in five specimens, 12 to 14, mean 13; of posterior pair, 10 to 14, mean 12.6.

Dorsal setae: Rather heavy with relatively few heavy setules. Length of humerals, 72 to 90; of setae near the middle of the first posthumeral row, 57 to 63; of setae in the posterior group, 50 to 54. Tendency for setae to occur out of line in anterior rows not so pronounced as in *E. luteodema*.

Dorsal formulae of five specimens from Jefferson County, Pa.:

2	..	14	..	11	..	2	..	10	..	8	..	6	..	2	(type)
2	..	15	..	17	..		..	13	..	8	..	7	..	1	
2	..	13	..	13	..	1	..	11	..	8	..	6	..	2	
2	..	14	..	16	..		..	12	..	9	..	6	..	3	
2	..	13	..	14	..		..	13	..	8	..	7	..	3	

Ventral setae: Setules on sternals and anterior poststernals fine, becoming heavier posteriorly. Data from five specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 40 to 50. Length of first sternals, 50 to 58; of second sternals, 42 to 50; of setae near the middle of the first poststernal row, 36 to 40; of setae in the posterior group, 47 to 56.

Anomaly: One nude second sternal on the type.

MATERIAL: Type, USNM 1995. Specimens from hosts:

*Marmota m. monax*

Pennsylvania

Jefferson County: Apr. 19, 1948, USNM-type+4, DU-7, RML-2, CEF-4, CM-2, KU-1, Afr-1, Aus-1; June 8, 1948, DU-4, CEF-1.

*Marmota*

Pennsylvania

Warren County: July 12, 1948, DU-1.

SEASONAL DISTRIBUTION: *E. marmotae* has been collected during the spring and summer months of April, June, and July.

GEOGRAPHIC DISTRIBUTION: *E. marmotae* has been collected in northwestern Pennsylvania (fig. 7,a).

DIAGNOSIS: *E. marmotae* has the characters of the "*luteodema*" group. It is easily distinguished from *E. luteodema* by having a genuala II and a genuala III.



**ECOLOGY:** According to Mr. Neil D. Richmond, the *Marmota* collected on Apr. 19, 1948 was taken in an orchard. The chiggers were attached in hair follicles on the back and sides of the host.

**CULTURES:** A single culture (No. 61) was established with the orange colored nymphs of *E. marmotae*.

Date established: May 2, 1948.

**Container:** Large, wide-mouth jar, 140 mm. by 135 mm., with plaster-charcoal base. On June 23, 1948, a wide-mouth pint jar completely lined with plaster-charcoal. On Aug. 24, 1948, a special plaster-charcoal lined vial.

**Medium:** Natural forest soil about 20 mm. in depth. On June 23, 1948, soil. On Aug. 24, none.

**Source:** About 130 nymphs from larvae engorged on *Marmota m. monax* collected Apr. 19, 1948.

**Food offered:** Before June 23, only the organisms contained in the soil medium. After June 23, *Aedes aegypti* eggs and May fly eggs in addition to the contained soil organisms. After Aug. 24, *Aedes aegypti* eggs.

**Results:** Nymphs disappeared into soil. One seen on May 21. Flooded culture with water on June 23 and recovered 48 active nymphs. Transferred nymphs to new container. Nymphs were observed regularly in the new container. On June 29 May fly eggs were placed in the culture. About 10 nymphs tried to feed on the May fly eggs. At times the contracting and expanding trombiculid feeding motion of the body occurred but no other evidence of feeding was detected. On June 30 no nymphs were in sight when the container was opened; but many soon appeared. One approached a mass of May fly eggs and seemed to try to feed. Body contractions and expansions occurred; but no other evidence was detected. On Aug. 24 the culture was flooded and four living nymphs were recovered. *Onychiurus* sp. also were recovered. *Aedes* larvae soon were active in the flotation. Nymphs transferred to new container. In the special vial no feeding attempts were observed. Nymphs were last observed alive on Aug. 31. All were dead on Sept. 6, 1948.

**LIFE HISTORY:** From the data of Culture 61, *E. marmotae* engorged larvae can metamorphose into nymphs in 13 days. Four nymphs survived 121 days.

**REMARKS:** Although *E. luteodema* and *E. marmotae* are easily distinguished morphologically and their known geographic ranges are widely separated, the two species are very similar. Collections of both are scant, but there is apparently a host preference for

species of *Marmota*. The nature of these correlations is yet to be determined.

### 13. *Euschöngastia hamiltoni* Brennan

FIGURE 7,a; PLATES 6, 17

*Euschöngastia hamiltoni* Brennan, 1947, pp. 251-252, fig. 4A-D.—Fuller, 1952, pp. 182, 184.

DESCRIPTION: Size: Engorged length, 560 to 740; width, 350 to 390.

Shape: Long oval.

Color: Pale yellow (Brennan, 1947).

Gnathosoma: Seta on palpal femur long, curved, with long setules set well apart in about three alternate rows on the outer curvature. Seta on genu shorter, with long setules spaced in about two alternate rows. Dorsal seta on palpal tibia arched anteriorly with a few long setules on the convex curvature; lateral seta usually nude, one on one specimen with three small setules; ventral seta rather short with setules spaced usually in two alternate rows. Palpal claw long, curved; with five prongs, median prong longest and heaviest, two somewhat shorter, and two smaller on the convex curvature. Galeal seta with one to four setules. Cheliceral base heavy, angulate posterolaterally; blade smooth with tiny subapical dorsal tooth and larger ventral tooth. Scattered punctae on palpal coxa and cheliceral base.

Legs: Leg I with two long, slender genualae and a rather long microgenuala, two typical tibialae and a microtibiala, a long spur with a microspur set almost the length of the spur distally, a subterminala, a parasubterminala, and a pretarsala. Leg II with a long, slender genuala, two tibialae, a rather slender spur with microspur just proximal to it, and a pretarsala. Leg III with a long, slender genuala. Nonspecialized setae with relatively few setules, some straight, others curving to form an open frill. Scattered punctae on all coxae, also on all other leg segments of some specimens.

Scutum: Somewhat rectangular in general outline. Anterior margin generally concave with a slight convexity at the anterior median seta. Lateral margins slightly concave, diverge posteriorly. Posterior margin generally parallels the anterior margin, slightly convex posterolateral to the pseudostigmata and slightly concave between them. The anterolateral and the posterolateral setae are on the slightly extended corners; anteromedian set close to margin. Setae with relatively few setules. Anterolateral

and posterolateral setae long and about the same length. Pseudostigmata set on or close to a line drawn between the posterolateral setae. Pedicel of sensilla distinct, enlarging into the ovoid head; anterior surface of head well clothed with setules, posterior surface and distal end more sparsely covered. An oblique ridge extends anterolaterally from near the anteromedian edge of each pseudostigma, curving posteriorly near the lateral margin and terminating near the posterior margin about halfway between the posterolateral seta and the pseudostigma.

Summary of standard data of the five specimens studied from New York and West Virginia (S's from two specimens):

AW 60-65, mean 62.6; PW 81-87, mean 83.6; AP 26-32, mean 28.2;  
SB 23-27, mean 25.2; ASB 25-29, mean 27; PSB 12-14, mean 12.8;  
AL 69-83, mean 73.4; AM 32-40, mean 35.4; PL 65-73, mean 69.2;  
S 25 and 27. Width of head of sensilla in two specimens, 15 and 15.

Eyes: Two pairs; anterior pair slightly anterior to posterolateral setae; posterior pair posterior to scutum. Size large, diameter of anterior eyes of five specimens, 14 to 16, mean 14.6; of posterior eyes, 13 to 14, mean 13.2.

Dorsal setae: With rather large, distinct setules; nude adjacent to body. Length of humerals, 57 to 69; of setae near the middle of the first posthumeral row, 54 to 57; of setae in the posterior group, 34 to 44.

Setal formulae for five specimens:

New York

Germantown: 2 .. 10 .. 10 .. .. 9 .. 7 .. 5 .. 4

Millertown: 2 .. 10 .. 9 .. 2 .. 8 .. 6 .. .. 5

West Virginia

Hardy County: 2 .. 10 .. 9 .. 1 .. 9 .. 6 .. 4

2 .. 11 .. 9 .. 2 .. 8 .. 6 .. 4 .. 2

2 .. 10 .. 10 .. 2 .. 8 .. 7 .. 6

Ventral setae: Poststernals similar in form to dorsals. Number of first sternals, 2; of second sternals, 2; of poststernals, 40 to 43. Length of first sternals, 40 to 52; of second sternals, 32 to 36; of setae near the middle of the first poststernal row, 25 to 32; of setae in the posterior group, 36 to 41.

MATERIAL: Borrowed from the Rocky Mountain Laboratory. New York specimens are paratypes. Specimens from hosts:

*Myotis subulatus leibii*

New York

Germantown: Mar. 17, 1946, 1.

*Eptesicus f. fuscus*

New York

Millertown: Feb. 12, 1947, 1.

*Myotis lucifugus*

West Virginia

Hardy County: Apr. 20, 1947, 3.

SEASONAL DISTRIBUTION: *E. hamiltoni* has been collected in February, March, and April.

GEOGRAPHIC DISTRIBUTION: *E. hamiltoni* has been collected from Dutchess and Putnam Counties, N. Y., and from Hardy County, W. Va. (fig. 7,a).

DIAGNOSIS: *E. hamiltoni* can be distinguished by the following combination of characters: No tibiala III, palpal claw with more than three prongs, scutum roughly rectangular, anterolateral setae and posterolateral setae long and about the same length.

REMARKS: *E. hamiltoni* has been collected only from bats in the eastern United States. Morphologically it is very distinct from the one other species, *E. pipistrelli*, reported from bats. A most unusual difference occurs in the eyes of the two species. *E. pipistrelli* has the most reduced eyes of North American *Euschöngastia*, and *E. hamiltoni* has the largest.

*E. hamiltoni* appears to be intermediate in character. Although it is a typical *Euschöngastia*, it cannot clearly be grouped morphologically with any other species.

#### The "*blarinae*" group

The "*blarinae*" group of *Euschöngastia* consists of five species. Diagnostic features include: No tibiala III; palpal claw with more than three prongs; scutum wider than long, more or less pointed at the posterolateral corners, anterolateral setae much shorter than the posterolaterals; lateral seta on palpal tibia nude; galeal seta with setules.

#### 19. *Euschöngastia blarinae* (Ewing)

FIGURE 7,d; PLATES 5, 8, 18

*Trombicula blarinae* Ewing, 1931, pp. 11-12, 19, pl. 1, fig. 1.—Radford, 1942, pp. 57, 59, fig. 3.—Michener, 1946, p. 431.—Sig Thor and Willmann, 1947, pp. 259, 271.

*Neoschöngastia blarinae*, Ewing, 1946c, pp. 21, 22.

*Euschöngastia blarinae*, Fuller, 1948, p. 103; 1952, pp. 182, 183.

DESCRIPTION: Size: Length, 205 to 600; width, 155 to 580.

Shape: Unengorged, broad ovoid, rounded posteriorly; engorged, ovoid to oval.

Color: Opaque white with red eyes.

Gnathosoma: Short and broad. Seta on palpal coxa with long setules. Seta on palpal femur rather heavy with long, spaced setules. Genual seta with about two short rows of long setules. Dorsal seta on palpal tibia with two alternate rows of setules; lateral seta nude, slender; ventral seta with a few long, alter-

nately arranged setules. Palpal claw varies from slightly curved to almost straight; rather slender; with five prongs, three of about equal length, the median prong somewhat heavier, and two shorter on the outer surface. Galeal seta usually with one to three setules (table 13). Base of chelicera heavy, blade smooth, subapical dorsal tooth greatly reduced, usually not discernible; ventral tooth distinct. Punctae on palpal coxa, none on cheliceral base.

TABLE 13.—*Distribution of setules on the galeal setae of 20 specimens of Euschöngastia blarinae*

Number of setules	Frequency
1	17
2	16
3	4
?	3

(Question mark indicates undetermined number of setules)

Legs: Leg I with two slender genualae and a microgenuala, two tibialae, the more proximal the longer, and a microgenuala, a middorsal spur with microspur about half the length of the spur distal, a subterminala, a small parasubterminala, and a pretarsala. Leg II with a slender genuala, two tibialae, a spur with microspur proximal and anterior, and a pretarsala. Leg III with a slender genuala. Most nonspecialized setae beyond trochanters with fine, curved setules; a few on dorsal surfaces with straight setules. Empodium slightly longer than claws. Leg segments stout; legs without noticeable taper. Coxae and distal leg segments punctate.

Anomalies: Two specimens with two setae on one coxa III. One specimen with one parasubterminala lacking. One specimen with three tibialae I on one leg.

Scutum: Slightly more than twice as wide as long. Anterior margin concave between anteromedian seta and anterolaterals. Lateral margins slightly concave, diverging posteriorly. Posterior margin approximately parallel to the anterior margin, convex posterolateral to the pseudostigmata and slightly concave between them. The four extended corners bear the anterolateral setae and the posterolateral setae. The anteromedian seta set near the margin on an anterior convexity. Posterolateral setae longest. All setae heavy with very large setules spaced on the shafts, the posterolaterals particularly appearing quite spiny. Pseudostigmata posterior to a line drawn between the posterolaterals. Sensillae long clavate, head enlarging evenly from the base of the pedicel for three-fourths its length and rounding off distally;

covered with large setules which tend to stand out in a frill on the basal half. Sensillae usually broken off. Anterior to each pseudostigma is a wide inverted U-shaped ridge, the inner leg terminating medial to the pseudostigma, the outer leg extending to the posterior margin; often obscured. Surface punctate. Usually a pair of pits larger than punctae near the ridge medial to each posterolateral seta.

Summary of standard data of 21 specimens of *E. blarinae* from over its range (AM's from 20 specimens, S's from 7):

AW 54-63, mean 57.5; PW 74-93, mean 80.2; AP 14-21, mean 17.7; SB 26-36, mean 29.6; ASB 21-28, mean 24.1; PSB 7-11, mean 8.4; AL 32-47, mean 40.4; AM 35-45, mean 40.6; PL 63-82, mean 70.2; S 35-39, mean 37.7. Width of head of sensilla of seven specimens, 9-11, mean 10.

Eyes: Two pairs; anterior pair lateral to posterolateral setae. Diameter of anterior eyes of eight specimens, 7 to 12, mean 9.4; of posterior eyes, 7 to 10, mean 8.5.

Dorsal setae: Similar to the scutal setae, with large setules spaced over the shaft; spiny appearance. In unengorged specimens humeral setae lie in first "posthumeral" row. Length of humerals of 16 specimens, 57 to 67; of setae near the middle of the first posthumeral row, 44 to 60; of setae in the posterior group, 35 to 47.

Dorsal setal formulae for 20 specimens:

#### North Carolina

Durham and Orange	2	..	11	..	8	..	..	10	..	8	..	6	..	2
Counties:	2	..	10	..	12	..	..	10	..	6	..	6	..	
	2	..	10	..	8	..	..	11	..	8	..	4	..	
	2	..	10	..	12	..	..	10	..	6	..	6	..	
	2	..	10	..	9	..	..	11	..	6	..	6	..	

#### Virginia

Giles County:	2	..	10	..	11	..	..	10	..	6	..	4	..	
	2	..	10	..	11	..	..	10	..	7	..	7	..	

#### District of Columbia

Rock Creek Park:	2	..	10	..	12	..	..	11	..	6	..	6	..	
	2	..	10	..	11	..	..	8	..	5	..	6	..	
	2	..	10	..	?	..	2	..	8	..	5	..	4	

#### Pennsylvania

Jefferson County:	2	..	10	..	13	..	..	10	..	6	..	6	..	
	2	..	10	..	10	..	..	11	..	6	..	6	..	2
Venango County:	2	..	10	..	12	..	..	12	..	6	..	6	..	
	2	..	10	..	9	..	2	..	10	..	6	..	6	1
	2	..	10	..	12	..	..	11	..	6	..	6	..	
Warren County:	2	..	10	..	9	..	..	10	..	8	..	6	..	
	2	..	10	..	12	..	..	11	..	6	..	6	..	
	2	..	10	..	10	..	..	12	..	6	..	6	..	1

Cameron County:	2 .. 9 .. 11 .. .. 9 .. 6 .. 6
Erie County:	2 .. 10 .. 8 .. .. 10 .. 8 .. 7 .. 2

Ventral setae: Poststernals smaller than dorsals but of the same general character with setules in proportion; increasing in size posteriorly. Data from 16 specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 38 to 47. Length of first sternals, 44 to 60; of second sternals, 38 to 51; of setae near the middle of the first poststernal row, 28 to 37; of setae in the posterior group, 35 to 48.

MATERIAL: Type (No. 1018) and paratypes in the U. S. National Museum. All other material in the Duke University collections. Specimens from hosts and unattached:

<i>Blarina brevicauda</i>	<i>Sorex f. fumeus</i>
District of Columbia	Pennsylvania
Rock Creek Park, Sept. 18, 1929,	Venango County: May 1947, 1.
4 (paratypes); Sept. 20, 1929,	<i>Sorex l. longirostris</i>
3 (paratypes).	Virginia
Pennsylvania	Giles County: Aug. 1947, 20.
Monroe County: May 1945, 1.	Soil, mammal runway
Warren County: Sept. 1947, 19;	North Carolina
Oct. 1947, 2.	Durham County: Feb. 1948, 1.
Erie County: Nov. 1947, 12.	<i>Sorex c. cinereus</i>
North Carolina	Pennsylvania
Durham County: Dec. 1947, 1.	Jefferson County: Apr. 1948, 1.
Orange County: Jan. 1948, 1;	Leaves from cavity of decayed-out
July 1948, 7; Oct. 1948, 2;	root system
Dec. 1949, 10.	North Carolina
<i>Peromyscus leucopus</i>	Orange County: Dec. 1948, 2.
District of Columbia	Forest Soil
Rock Creek Park, Sept. 20, 1929,	North Carolina
1 (type).	Orange County: Dec. 1948, 1
<i>Blarina b. brevicauda</i>	Decayed root system
Pennsylvania	North Carolina
Venango County: Apr. 1947, 23;	Orange County: Mar. 1949, 1.
May 1947, 13.	<i>Blarina</i> sp.
Warren County: Sept. 1947, 12.	Pennsylvania
Venango County: Apr. 1948, 25.	Cameron County: Sept. 1949, 5.
Jefferson County: Apr. 1948, 3.	

GEOGRAPHIC DISTRIBUTION: *E. blarinae* has been collected in Durham and Orange Counties, N. C., Giles County, Va., the District of Columbia, and northwestern Pennsylvania (fig. 7,d).

SEASONAL DISTRIBUTION: Over its range *E. blarinae* has been collected from its hosts in every month of the year except June. In Orange County, N. C., it has been collected in almost equal numbers from single hosts in July and December. The record of

collections from shrews in the Duke Forest area shows the single *Blarina brevicauda* trapped in January was infested with *E. blarinae*; one *B. brevicauda* trapped in March and two trapped in April were not infested; one of two *B. brevicauda* trapped in July was infested; the single *B. brevicauda* trapped in September was not infested; the one trapped in October was infested; and two out of three trapped in December were infested. A summary of these collections shows one positive host out of five hosts collected from April to September and four positive hosts out of six hosts collected from October to March. However, at this time collections are not adequate for any reasonable picture of seasonal distribution for *E. blarinae*.

DIAGNOSIS: *E. blarinae* can be distinguished from other species in the "*blarinae*" group by the following combination of characters: Scutum and free leg segments punctate, cheliceral base without punctae, and galeal setae branched. The heavy scutal and dorsal setae clothed with uniformly large setules will distinguish the species in good preparations. When the distinctive sensillae are present, they alone will serve to differentiate *E. blarinae*.

ECOLOGY: In Pennsylvania, *E. blarinae* was collected from shrews which were trapped in a variety of situations. According to Mr. Neil Richmond, hosts were taken among weeds and briars along a railroad. The ground was cool and wet. The weather was hot in late summer. They were taken in a narrow, rocky ravine where hemlock and yellow birch were the dominant trees. The site was cool and well watered. Some nights were below freezing in late spring. Hosts infested with the chiggers were trapped in hardwoods on a dry ridge in September. They were taken, also, among black and yellow birch, hemlock, and red maple on a round, well-watered knoll in May.

In Duke Forest most host shrews were trapped in the oak-hickory upland hardwoods communities. One of the December collections and the January collection were made on well-drained ridge tops at a small decayed-out stump and at a pile of stones. The other December collection was at the base of a small shrub on a gently sloping hillside. The weather was cold or freezing. The July collection was from a level area between two slopes. The October collection was made from a narrow bottomland along a permanent stream. River birch, yellow poplar, and sweet gum were the dominant trees.

The one common factor in all collections was shrews. *E. blarinae* was found on no other hosts in collections from the Duke



Forest area and in the collections shipped in by other workers. The chiggers were found crawling on the fur or imbedded in craters in the skin of *Blarina* on the posterior portion of the venter and on the rump. Other collectors usually reported the same distribution on this host. Mr. Richmond reported collecting them from folds in the pinna of *Sorex c. cinereus*.

Unengorged, unattached *E. blarinae* have been collected from forest soil, from forest soil surrounding a mammal runway, and from materials in decayed-out root systems. This distribution is consistent with its apparent host preference.

**CULTURES:** Five cultures containing *E. blarinae* were established. One was started with engorged larvae, the others with nymphs. In one culture nymphs were identified from their cast larval skins. *Sinella curviseta* was established in this culture and developed well. No stage of *E. blarinae* beyond nymph was obtained.

**LIFE HISTORY:** From collection and culture records it was determined that nymphs could develop from engorged larvae in 16 days or less. One nymph was observed alive 48 days after its culture had been established.

**REMARKS:** With a single exception all known collections of *Euschöngastia blarinae* have been from shrews. The single exception is that of the type specimen which is recorded from the deer mouse, *Peromyscus leucopus*. This seeming anomaly in distribution on hosts focuses attention on the type specimen. The attention becomes critical when it is considered that other species of chiggers which can be confused with *E. blarinae* usually occur on *P. leucopus*. Further, the hosts from which *E. blarinae* was originally described were reported as *Blarina brevicauda* and *Peromyscus leucopus*. The type host was given as *Blarina brevicauda*. However, the label on the type slide (USNM 1018) bears the host name *Peromyscus leucopus*. There is the possibility of confusion in labeling.

The one specimen, the holotype, on the type slide has been carefully examined. The sensillae are missing. Various other diagnostic characters are obscured. It does resemble the paratypes listed from shrews. It also bears a certain resemblance to *E. setosa*, which is found on *Peromyscus*. At the present time it cannot be positively identified. The paratypes, like the type, have the sensillae missing and various other diagnostic characters are obscured. Weak evidence can be obtained from the paratypes indicating conspecificity with the material described here from

the Duke University collections. The doubt cast on the type specimen by its host record has not been eliminated by its morphology. On the other hand there is no proof that it is not conspecific with the paratypes and with the new material described here. Although some question may remain concerning the type specimen or its host record, there is no basis for disturbing the nomenclature and the name *Euschöngastia blarinae* is retained for the species redescribed here.

20. *Euschöngastia carolinensis*, new species

FIGURE 7,c; PLATES 2, 5, 7, 19

DESCRIPTION: Size: Length, 230 to 550; width, 155 to 460.

Shape: Unengorged in life, broad oval; all preserved specimens, broad oval.

Color: Opaque white to cream, with red eyespots.

Gnathosoma: Seta on palpal coxa with a fringe of setules on the convex curvature. Seta on palpal femur strong with strong setules. Seta on palpal genu with setules closely arranged in two alternate rows. Dorsal seta on palpal tibia with few setules; lateral seta slender and nude; ventral seta with setules closely arranged in two alternate rows. Palpal claw stout, without taper, terminating in six or seven closely grouped prongs, median prong slightly the longest. Galeal seta with about two to six setules (table 14). Cheliceral base heavy, faintly punctate; blade smooth, curved, with tiny subapical dorsal tooth and a larger ventral tooth. Conspicuous punctae on palpal coxa.

TABLE 14.—*Distribution of setules on the galeal setae of ten specimens of Euschöngastia carolinensis*

Number of setules	Frequency
2	1
3	6
4	9
5	2
6	1
?	1

(Question mark indicates undetermined number of setules)

Legs: Leg I with two rather long genualae, a microgenuala, two tibialae with a microtibiala, a spur of moderate size with a microspur about two-thirds the length of the spur distal and posterior to it, a stout subterminala, a rather small parasubterminala, and a pretarsala. Leg II with a rather long genuala, two tibialae, a moderate spur with microspur slightly proximal and

anterior to it, and a pretarsala. Leg III with a slender genuala. Nonspecialized setae distal to trochanter of leg I rather slender with a frill of numerous, short, curved setules; setae on the dorsal surface of tarsus with few, straight setules. Both sorts of non-specialized setae beyond trochanter of leg II; those dorsal and anterior tending to have fewer, straight setules; those ventral and posterior tending to have numerous, short, curved setules. Most feathered setae on leg III with short, curved setules. Empodium more slender than claws but about the same length. All coxae punctate; all distal segments may have few punctae, usually present on segments 4, 5, and 6. Segments stout; legs without noticeable taper.

Scutum: The form in general similar to that of *E. blarinae*, with similar ridges, but with a slightly less regular outline. Punctae usually not distinguishable; sometimes found within areas bounded by the ridges. Usually two pits near the posterolateral terminus of each ridge. Scutal setae with heavy shafts well covered with slender, rather long setules. Sensillae clavate, heads enlarging more abruptly than in *E. blarinae*, largest about two-thirds the length from the base; usually somewhat pointed on the distal end; closely covered with moderate setules on the anterior surface, sparsely covered on the posterior surface.

Standard data for five specimens from Orange County, N. C.:

AW	PIF	AP	SB	ASB	PSE	AL	AM	PL	S
60	81	19	27	22	8	50	36	67	35 x 12 (type)
63	92	23	32	27	8	51	25	70	
60	78	17	26	22	8	45	35	69	32
61	79	18	29	22	7	52		66	33 x 12
58	76	19	25	22	8	50	35	66	32 x 11

Eyes: Two pairs; rather small. Anterior pair just lateral to the posterolateral setae. Data from five specimens: Diameter of anterior eyes, 7 to 9, mean 8.4; of posterior eyes, 6 to 9, mean 7.4.

Dorsal setae: Two distinct forms. Setae in the first two post-humeral rows tend to be nude adjacent to body; on lateral edges adjacent to body are two alternate rows of larger setules; numerous, more slender setules cover the lateral and opposite surfaces. Setae in the three posterior rows flattened, lanceolate, leaflike, with short, sharp setules on lateral edges and the surface away from the body. The flattened setae sometimes occur at the ends of the second posthumeral row. Data from five specimens: Length of humerals, 59 to 63; of setae near the middle of the first post-humeral row, 54 to 56; of setae in the posterior row, 47 to 57.

Dorsal formulae for five specimens from Orange County, N. C.:

2	..	10	..	10	..	12	..	8	..	4	(type)
2	..	10	..	12	..	12	..	7	..	6	
2	..	10	..	10	..	12	..	8	..	4	
2	..	10	..	10	..	11	..	8	..	4	
2	..	10	..	10	..	12	..	6	..	6	

Ventral setae: Poststernals with numerous setules of moderate length. The most posterior row of setae about the level of the anus; continuous with the most posterior row of dorsals; usually with some flattened setae. Data from five specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 33 to 40. Length of first sternals, 48 to 54; of second sternals, 38 to 41; of setae near the middle of the first poststernal row, 31 to 37; of posterior setae, 41 to 58.

MATERIAL: Type, USNM 1996. Specimens from hosts and unattached; all in North Carolina:

*Pitymys p. pinctorum*

Orange County: May 9, 1948,  
CEF-1.

Cavities of decayed root systems and  
under decaying stumps

Orange County: Mar. 20, 1949,  
KU-1; Jan. 22, 1950, CEF-1.

*Peromyscus leucopus*

Orange County: July 3, 1949,  
CEF-1.

Surface soil

Orange County: Jan. 1, 1950,  
USNM-Type+2, DU-3, RML-1;  
Jan. 7, 1950, CM-1.

SEASONAL DISTRIBUTION: Collections of *E. carolinensis* have been made in winter, spring, and summer. Records are too few to determine if seasonal population peaks occur.

GEOGRAPHIC DISTRIBUTION: *E. carolinensis* has been collected only in Orange County, N. C. (fig. 7,c).

DIAGNOSIS: *E. carolinensis* can be distinguished from the other members of the "*blarinae*" group by the flattened, leaflike setae in the three posterior dorsal rows. It is most like *E. ohioensis*, but there is only one row of flattened dorsal setae in the latter species.

ECOLOGY: Both host records for *E. carolinensis* are from mice trapped in the New Hope Creek Division of Duke Forest. The *Pitymys* was taken in a north-facing ravine in Compartment 6. Beech was represented among the dominant trees. The *Peromyscus* was taken among the second growth of a cut-over ridge top in Compartment 11. The unattached chiggers were collected from sites in upland hardwoods in the Durham Division of the forest. One was from an east-facing slope, one from a west-facing slope and one from the ridge top.

Only one chigger was removed directly from a host. It was found free on the fur near the anus of *Pitymys*.

REMARKS: The type specimen of *E. carolinensis* is an unengorged, unattached specimen collected from soil (pl. 2).

## 21. *Euschöngastia ohioensis*, new species

FIGURE 7,c

DESCRIPTION: Size: Length, 240 to 675; width, 160 to 705.

Shape: Oval to broad oval to almost square; specimens flattened on sides sometimes wider than long.

Color: Cream to opaque white.

Gnathosoma: Generally similar to that of *E. carolinensis*. Genual seta with fewer setules. Palpal claw usually slightly curved; with five to seven prongs, three longer with the median of these longest; form similar to that of *E. setosa*. Galeal seta usually with two to five setules (table 15).

TABLE 15.—Distribution of setules on the galeal setae of ten specimens of *Euschöngastia ohioensis*

Number of setules	Frequency	Number of setules	Frequency
2	1	5	1
3	7	?	1
4	10		

(Question mark indicates undetermined number of setules)

Legs: Generally as in *E. carolinensis*.

Scutum: Generally similar to that of *E. carolinensis*; larger. Punctae usually visible. Anterolateral and anteromedian setae similar to those of *E. carolinensis*; posterolateral setae with two alternate rows of heavy setules spaced along lateral edges of the side adjacent to body as the seta projects posteriorly; the portions of the setae opposite to the body closely covered with small setules.

Standard data of the type specimen from Clermont County, Ohio:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
66	97	22	35	25	7	54	32	65	35 x 11

Summary of standard data of six specimens, including the type, from over its range (AM's and S's from five specimens):

AW 66-78, mean 72.2; PW 90-113, mean 104.2; Ap 21-26, mean 22.8; SB 32-44, mean 37.2; ASB 25-31, mean 27.5; PSB 7-10, mean 8.2; AL 44-58, mean 53; AM 32-32, mean 32; PL 60-66, mean 63.2; S 35-36, mean 35.4. Width of head of sensilla in five specimens, 11 to 13, mean 11.8.

Eyes: Two pairs, often difficult or impossible to find in this material. Data from two specimens: Diameter of anterior eyes, 7 to 10, mean 8.5; of posterior eyes, 6 to 7, mean 6.5.

Dorsal setae: Two distinct forms. Setae in the four anterior posthumeral rows somewhat similar to the anterior dorsal setae of *E. carolinensis*, but with a very striking disproportion in size between the two rows of heavy setules and the smaller opposite setules. The flattened, leaflike setae confined mostly to the last posthumeral row. Occasionally a few like the anterior dorsals in the final row, or a few flattened setae laterally in the fourth posthumeral row. Length of humerals in six specimens, 54 to 63; of setae near the middle of the first posthumeral row, 48 to 55; of setae in the posterior row, 48 to 54.

Dorsal setal formulae for six specimens:

Ohio

Clermont County: 2 .. 12 .. 14 .. 14 .. 9 .. 6

Pennsylvania

Indiana County: 2 .. 12 .. 12 .. 13 .. 8 .. 6

Warren County: 2 .. 11 .. 12 .. 12 .. 7 .. 4

Cameron County: 2 .. 11 .. 12 .. 10 .. 7 .. 4

Lycoming County: 2 .. 12 .. 15 .. 14 .. 8 .. 4

New Jersey

Mount Holly: 2 .. 13 .. 15 .. 15 .. 8 .. 6

Ventral setae: Poststernals generally similar to those of *E. carolinensis*. Data from six specimens: Length of first sternals, 44 to 57; of second sternals, 44 to 48; of setae near the middle of the first poststernal row, 32 to 42; of posterior setae, 40 to 57.

MATERIAL: Type, USNM 1997. Specimens from hosts:

*Pitymys pinetorum scalpsides*

Pennsylvania

Warren County: Sept. 8, 1947.  
DU-8. Afr-1. Aus-1.

New Jersey

Mount Holly: Oct. 30, 1948.  
USNM-1. DU-4.

*Synaptomys cooperi saluratus*

Ohio

Clermont County: Mar. 5, 1948.  
DU-1: Mar. 20, 1948, CEF-1;  
Feb. 25, 1949, USNM-type-2;  
Feb. 27, 1949, RML-2.

*Pitymys pinetorum auricularis*

Ohio

Hamilton County: Mar. 5, 1948.  
DU-1.

*Clethrionomys g. gapperi*

Pennsylvania

Lycoming County: Mar. 30, 1949,  
USNM-1, DU-2, CEF-1, CM-2.

*Synaptomys cooperi stenei*

Pennsylvania

Indiana County: Apr. 22, 1949,  
KU-1.

*Pitymys* sp.

Pennsylvania

Cameron County: Sept. 1, 1949,  
DU-4, CEF-4.

SEASONAL DISTRIBUTION: Known collections of *E. ohioensis* have been made in fall, winter, and spring. Information is not adequate to determine variations, if any, in seasonal occurrence.

GEOGRAPHIC DISTRIBUTION: *E. ohioensis* has a northern distribution. Collections have been made from southwestern Ohio, through north-central Pennsylvania, to south-central New Jersey (fig. 7,c).

DIAGNOSIS: *E. ohioensis* is most similar to *E. carolinensis*. It can be distinguished from that species by the fewer leaflike setae confined mostly to the last posterior row, by the difference in the anterior dorsal setae, and by the greater number of dorsal setae.

ECOLOGY: The Warren County, Pa., collections were reported to have been made near a poorly drained ridge top among red maple, black oak, and cucumber tree. The Hamilton County, Ohio, locality was reported to be a hilltop grown up in black locust (6 to 30 feet), elm, and ailanthus; timothy and bluegrass, blackberry and dewberry covered the ground. Two localities were reported from Clermont County, Ohio. One was a steep slope with southern exposure, covered with timothy, bluegrass, blackberry, goldenrod, and sweet clover, and small elms and locust. The second locality was rolling farm land, idle for a couple of years, with locust seedlings or shrubs in bluegrass and blackberry.

Collectors generally reported *E. ohioensis* chiggers to be located around the anal opening of the hosts. They were also reported partially imbedded in the skin over most of the abdomen, the back, and the front legs.

REMARKS: No drawings were made for *E. ohioensis*. In general, the set of drawings for *E. carolinensis* will serve for *E. ohioensis*. However, the palpal claw more closely resembles that of *E. setosa*. The scutum is larger and punctate. It is possible the generally larger size of the scutum is more apparent than real. The larger scutal measurements came from well engorged specimens. The specimen from Lycoming County, Pa., was unengorged, and its measurements are close to those of *E. carolinensis*, only one of which was at all engorged.

*Euschöngastia carolinensis* and *Euschöngastia ohioensis* are morphologically and geographically distinct; but they share obvious morphological similarities. There is some evidence that they have similar host preferences. One of two collections from hosts for *E. carolinensis* was from *Pitymys*. Four of ten collections from hosts for *E. ohioensis* were from *Pitymys*. Possibly they attach to similar areas on hosts. From this evidence there is a possibility the two are subspecies. Further collections are

required to determine the exact relationship between *E. carolinensis* and *E. ohioensis*.

22. *Euschöngastia crateris*, new species

FIGURE 7,c; PLATES 5, 8, 19

DESCRIPTION: Size: Length, 275 to 800; width, 195 to 800.

Shape: Ovoid; broad oval; almost square.

Color: Yellowish, when dissicated.

Gnathosoma: Seta on palpal femur large and strong with numerous long, slender setules. Seta on palpal genu smaller, with many long, slender setules. Dorsal seta on palpal tibia slender with a few slender setules; lateral seta usually nude, occasionally with one or two small setules; ventral seta with long slender setules. Palpal claw with four or five prongs, three longer with the median prong longest and one or two shorter on the outer curvature. Long spur on palpal tarsus. Galeal seta heavy, curved, with rather long curved setules arising on opposite edges. Chelicer base heavy; blade with a rather large dorsal tooth and a large ventral tooth. Punctae on palpal coxa and chelicer base.

Legs: Leg I with two slender genualae and a microgenuala, two tibialae and a microtibiala, a spur of moderate size with a microspur about half the length of the spur distal and posterior, a slender subterminala and a small parasubterminala, and a pretarsala. Leg II with a slender genuala, two tibialae, a moderate spur with a microspur proximal or anterior to it, and a pretarsala. Leg III with a genuala. Nonspecialized setae similar in form and distribution to those of *E. carolinensis*. Empodium slightly longer than claws. Leg segments strong; legs without noticeable taper. All segments with punctae.

Anomalies: One specimen with three genualae I. One specimen with a tibiala III.

Scutum: General form much like that of *E. blarinae*. Punctae scattered. Pits near the posterolateral ends of the ridges usually distinct. Scutal setae with heavy shafts closely covered with long, slender setules. Sensillae broad clavate; heads frequently somewhat pyriform, clearly distinct from pedicels.

Standard data of the type specimen from Blair County, Pa.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
65	85	17	28	27	11	38	41	63	32 x 16

Summary of standard data of seven specimens, including the type, from over the range (AP's from six specimens, ASB's from five, S's from four):



AW 65-99, mean 78.9; PW 85-121, mean 101.7; AP 17-21, mean 19; SB 28-47, mean 36.4; ASB 25-37, mean 30.6; PSB 9-11, mean 10.1; AL 32-41, mean 37.3; AM 35-42, mean 38.4; PL 57-66, mean 60.6; S 32-38, mean 35.3. Width of sensilla of four specimens, 14 to 16, mean 15.

Eyes: Two pairs; anteriors lateral to posterolateral setae. No ocular plate, although there is some appearance of one in unengorged specimens. Measurements from five specimens: Diameter of anterior eyes, 11 to 13, mean 12.2; of posterior eyes, 8 to 11, mean 9.8.

Dorsal setae: Similar in form to the anterior dorsal setae of *E. ohioensis* but with somewhat less disproportion in size of the two kinds of setules. A strong tendency for extra setae in the rows. Measurements for eight specimens: Length of humerals, 57 to 63; of setae near the middle of the first posthumeral row, 51 to 61; of posterior setae, 38 to 46.

Dorsal formulae for seven specimens from Pennsylvania:

Blair County:	2 .. 16 .. 2 .. 14 .. 2 .. 15 .. 11 .. 9 .. 4 .. 2 (type)
	2 .. 16 .. 2 .. 20 .. 2 .. 16 .. 9 .. 7 .. 4
Bradford County:	2 .. 14 .. .. 18 .. .. 15 .. 10 .. 8 .. 8
Venango County:	2 .. 18 .. .. 14 .. .. 16 .. 10 .. 9 .. 5
	2 .. 16 .. .. 16 .. .. 14 .. 10 .. 9 .. 6
	2 .. 15 .. .. 17 .. .. 13 .. 11 .. 9 .. 6 .. 2
Mercer County:	2 .. 18 .. .. 16 .. 2 .. 16 .. 9 .. 10 .. 7 .. 2

Ventral setae: Poststernals with numerous setules. Data from eight specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 54 to 68. Length of first sternals, 47 to 55; of second sternals, 39 to 50; of setae near the middle of the first poststernal row, 32 to 35; of setae in the posterior group, 44 to 49.

MATERIAL: Type, USNM 1998. Specimens from hosts, all from Pennsylvania:

<i>Clethrionomys gapperi</i>	Bradford County: Oct. 30, 1949,
Wayne County: July 9, 1945, KU-1.	DU-1, RML-2.
<i>Clethrionomys gapperi paludicola</i>	<i>Peromyscus maniculatus</i>
Venango County: Apr. 18, 1947,	Venango County: Jan. 23, 1948,
CM-1.	DU-1.
<i>Peromyscus leucopus noveboracensis</i>	<i>Peromyscus leucopus</i>
Mercer County: July 11, 1947,	Blair County: June 26 or 27, 1949,
DU-1.	USNM-type+2, DU-3, CEF-2,
Blair County: June 8, 1949, DU-1.	Aus-1, Afr-1.
<i>Peromyscus</i> sp.	<i>Clethrionomys</i> sp.
Venango County: Jan. 20, 1948,	Bradford County: Nov. 11, 1949,
USNM-1, CM-1.	CEF-1; Nov. 13, 1949, CEF-1.

SEASONAL DISTRIBUTION: *E. crateris* has been collected in all seasons.

GEOGRAPHIC DISTRIBUTION: *E. crateris* has been collected in Pennsylvania from the northwestern, the central, and the north-eastern parts of the State (fig. 7,c).

DIAGNOSIS: *E. crateris* can be distinguished from the other members of the "*blarinae*" group by the shape of its galeal setae, by the long spur on the palpal tarsus, and by the large number of dorsal setae.

ECOLOGY: Concerning the collection of June 26 or 27, 1949, Mr. C. L. Gifford noted: "These were taken on hot, dry cliffs of limestone and dolomite. A number of *Peromyscus* were taken there and they were almost 100% infested with that type of chigger." Unpreserved ears of this collection were received in the laboratory. The ears and the chiggers were dessicated. The chiggers were found in pits, particularly along the edge of the pinna.

REMARKS: *E. crateris* has been named for the pits or craters in which it was found on the ears of *Peromyscus*.

### 23. *Euschöngastia setosa* (Ewing)

FIGURE 8,a; PLATES 8, 18

*Trombicula setosa* Ewing, 1937, pp. 170-171.—Radford, 1942, p. 60.—

Michener, 1946, p. 432.—Sig Thor and Willmann, 1947, pp. 258, 273.

*Euschöngastia setosa*, Fuller, 1948, pp. 103, 104; 1952, p. 184.

DESCRIPTION: Size: Length, 205 to 635; width, 150 to 590.

Shape: Unattached in life, ovoid, idiosoma rounded. Preserved, broad ovoid to broad oval.

Color: Yellowish with red eyes.

Gnathosoma: Seta on palpal femur well covered with setules on outer curvature. Seta on palpal genu with a few long setules, often in two rows. Dorsal seta on palpal tibia with a few alternate setules; lateral seta nude; ventral seta with a few slender setules on the dorsal half of the shaft. Palpal claw curved, with five to seven prongs. Galeal seta with about two to six setules; form variable, branched, pectinate, or with setules arising from opposite sides of the shaft; an occasional seta resembling those of *E. crateris*. Cheliceral base angulate laterally; blade with a very tiny dorsal tooth and a small ventral tooth. Punctae on palpal coxa; tiny punctae on cheliceral base, not always discernible.

Legs: Leg I with two slender genualae and a microgenuala, two tibialae and a microtibiala, a short spur on the proximal half of the tarsus with a microspur about two-thirds the length of the spur distal and slightly posterior, a subterminala, a parasubterminala, and a pretarsala. Leg II with a genuala, two tibialae, a middorsal spur of moderate length with a microspur proximal

or anterior to it, and a pretarsala. Leg III with a genuala. Non-specialized setae beyond trochanter of leg I mostly with numerous, fine, short, curving setules; those on dorsal surface of the tarsus with fewer, straight setules. Nonspecialized setae of leg II with numerous, curved setules on the posterior and ventral surfaces and fewer, straighter setules on the anterior and dorsal surfaces. Most nonspecialized setae on leg III with few, straight setules; those on the dorsal surface generally with curved setules. Empodium slender, slightly longer than claws. All coxae with small punctae. Punctae apparently lacking on distal leg segments usually; but a few specimens with very fine punctae on clear, flattened segments.

Scutum: Generally similar in form to that of *E. blarinae*, with a tendency to be wider in engorged specimens. Ridges frequently obscured. Two pits usually present near the posterolateral end of each ridge. Without apparent punctae. Setae similar to those of *E. blarinae*, but less heavy and with less heavy setules. Sensillae clavate; pedicel long and slender; head ovoid, well covered with setules on the anterior surface, sparsely covered on the posterior surface.

Standard data of the cotype from Okefenokee Swamp, Ga.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
65	95	19	30	23	8	-	-	60	-

Summary of standard data of eight specimens, including the cotype, from over the range (AL's from seven specimens, AM's from five, S's from three):

AW 60-77, mean 64.5; PW 80-112, mean 90.5; AP 16-20, mean 18.4; SB 25-42, mean 30.4; ASB 19-26, mean 23.3; PSB 7-10, mean 7.9; AL 29-38, mean 33.4; AM 32-37, mean 34.6; PL 56-65, mean 61.1; S 32-26, mean 34.3. Width of head of sensilla in three specimens, 14, 16, and 17.

Eyes: Two pairs; anterior pair lateral to posterolateral setae. Data from four specimens: Diameter of anterior eyes, 11 to 14, mean 12.8; of posterior eyes, 9 to 13, mean 11.3.

Dorsal setae: General form similar to that of *E. blarinae* but with setules less heavy. Length of humerals of eight specimens, 50 to 63; of setae near the middle of the first posthumeral row, 46 to 57; of setae in the posterior group, 35 to 42.

Dorsal formulae of eight specimens:

#### Georgia

Okefenokee Swamp: 2 .. 10 .. 10 .. 2 .. 9 .. 2 .. 6 .. 6 (cotype)

#### North Carolina

Orange County: 2 .. 11 .. 10 .. 2 .. 11 .. .. 6 .. 6

2 .. 10 .. 10 .. .. 10 .. .. 6 .. 3

Durham County:	2	..	10	..	10	..	2	..	11	..	2	..	5	..	4
Pennsylvania															
Somerset County:	2	..	10	..	8	..	2	..	10	..	..	7	..	4	
Bradford County:	2	..	10	..	10	..	2	..	10	..	..	6	..	6	
	2	..	10	..	11	..	..	12	..	..	8	..	6		
	2	..	10	..	10	..	2	..	10	..	..	6	..	6	

Ventral setae: Poststernals anterior to anus generally with fine setules; posterior to anus similar to dorsals. Data from eight specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 34 to 41. Length of first sternals, 38 to 50; of second sternals, 36 to 44; of setae near the middle of the first poststernal row, 32 to 36; of posterior setae, 36 to 38.

MATERIAL: Cotype, USNM 1256. All other specimens in the Duke University collections. Specimens from hosts and unattached:

*Peromyscus g. gossypinus*

Georgia

Okefenokee Swamp: Dec. 2, 1934,  
1 (cotype).

*Clethrionomys gapperi paludicola*

Pennsylvania

Venango County: May 1, 1947, 1.

*Napeozapus insignis*

Pennsylvania

Venango County: May 4, 1947, 2.

*Peromyscus leucopus noveboracensis*

Beaver County: May 20, 1947, 1.

*Clethrionomys* sp.

Pennsylvania

Somerset County: Sept. 3, 1947, 1.

Bradford County: Nov. 10, 1949,

2; Nov. 11, 1949, 1; Nov. 13,

1949, 1.

*Peromyscus leucopus*

North Carolina

Orange County: Dec. 7, 1947, 2;

Dec. 28, 1947, 2; Jan. 1, 1948,

1; Jan. 9, 1949, 1; Jan. 23,

1949, 3; Jan. 30, 1949, 1; May,

1, 1949, 1.

Durham County: Feb. 8, 1948, 1;

Dec. 5, 1948, 1.

*Sylvilagus floridanus mallurus*

North Carolina

Orange County: Dec. 27, 1949, 4.

Under old stump

North Carolina

Orange County: Jan. 22, 1950, 1.

SEASONAL DISTRIBUTION: *E. setosa* has been collected in fall, winter, and spring.

GEOGRAPHIC DISTRIBUTION: *E. setosa* has been collected in localities from the Okefenokee Swamp in Georgia, through North Carolina, to northern Pennsylvania (fig. 8,a).

DIAGNOSIS: *E. setosa* can be distinguished from other members of the "*blarinae*" group by the following combination of characters: No leaflike setae on the posterior of the body, scutum and distal leg segments without apparent punctae, head of sensilla ovoid.

ECOLOGY: *E. setosa* usually was taken in small numbers from *P. leucopus* in association with *E. peromysci*. The one collection

of an unattached, unengorged chigger was made at the type locality of *E. rubra* (pl. 2).

REMARKS: The original description of *E. setosa* included the species in an "akamushi" group of the genus *Trombicula*. *E. setosa* was included in a key of the "akamushi" group. The type slide given was USNM 1256; the type host, *Peromyscus g. gossypinus*; the type locality, Okefenokee Swamp, Ga. Fuller (1948) examined the cotypes and placed the species in the genus *Euschöngastia*. The original description and key validated the name. The type specimen or the cotypes are the namebearers for the species. One of the cotypes of *E. setosa* has been examined during this study. The important sensillae are missing, but the specimen belongs to *Euschöngastia*. Fuller's new combination is here considered to be correct and the name of the species to be *E. setosa*.

The specimen on the slide in the U. S. National Museum marked "C. E. F. X." is here designated lectotype.

#### 24. *Euschöngastia sciuricola* (Ewing)

FIGURE 8,a; PLATES 8, 21

*Schöngastia sciuricola* Ewing, 1925b, pp. 261-262; 1929c, p. 297.

*Neoschöngastia sciuricola*, Ewing, 1931, p. 5.—Radford, 1942, p. 74.—Sig Thor and Willmann, 1947, pp. 311, 312.

*Euschöngastia americana* Ewing, 1938, p. 293; 1946c, p. 22.—Sig Thor and Willmann, 1947, p. 317.—Fuller, 1952, pp. 182, 183.

*Euschöngastia sciuricola*, Fuller, 1948, p. 108; 1952, pp. 182, 183, 184.—Brennan, 1948, p. 473.—Wharton, Jenkins, et al., 1951, pp. 27-28.

DESCRIPTION: Size: Length, 430 to 740; width, 310 to 675.

Shape: Oval; ovoid; almost round.

Gnathosoma: Seta on palpal femur rather long with long, spaced setules. Seta on palpal genu smaller with two rows of slender setules. Dorsal seta on palpal tibia with few setules; lateral seta nude, occasionally with one or two tiny setules; ventral seta rather long with three or four rows of setules. Palpal claw curved, with five to seven prongs; median prong longest with two accessories slightly shorter; other prongs more proximal on the convex curvature. Galeal seta with about two to four setules. Chelicera with heavy basal segment; blade with a tiny, distinct dorsal tooth near apex and a larger ventral tooth. Punctae on palpal coxa; none apparent on cheliceral base.

Legs: Leg I with two slender genualae and a microgenuala, two tibialae and a microtibiala, a spur with a microspur about two-thirds the length of the spur distal and slightly posterior to it, a subterminala, a parasubterminala, and a pretarsala. Leg II

with a slender genuala, two rather small tibialae, a tapered spur with a microspur just proximal to it, and a pretarsala. Leg III with a genuala. Nonspecialized leg setae similar in form and arrangement to those of *E. setosa* but somewhat longer. Empodium slender, longer than the claws. Fine punctae sometimes discernible on coxae; other leg segments apparently without punctae.

Scutum: Somewhat similar in general form and outline to that of *E. blarina* but larger and more extended at the posterolateral corners. Apparently subject to distortion. Crescentic ridge anterior to each pseudostigma; usually obscured. No punctae apparent. Pits usually present about midway between the posterolateral seta and the pseudostigma on each side. Setae similar to those of *E. setosa*. Sensillae widely clavate; heads truncate at tips, closely covered with setules on the anterior surface, rather sparsely covered on the posterior surface; pedicels distinct.

Anomaly: Perhaps induced by flattening an engorged specimen on a slide, in one specimen the anterior and posterior margins formed concentric curves, and a line drawn between the posterolateral setae fell anterior to the anteromedian seta.

Standard data of a cotype of *E. americana* from Boise County, Idaho:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
68	95	22	25	21	12	34	34	66	22 x 17

Summary of standard data of five specimens, including the cotype (AL's, AM's, and S's from four specimens):

AW 62-80, mean 70.4; PW 82-119, mean 99.4; AP 18-22, mean 20.4; SB 25-44, mean 33.6; ASB 21-32, mean 25.4; PSB 8-18, mean 12.4; AL 34-38, mean 35.3; AM 34-39, mean 36.3; PL 66-79, mean 72; S 22-35, mean 29.5. Width of head of sensilla in four specimens, 15 to 17, mean 16.

Eyes: Two pairs; anterior pair lying just anterior to the posterolateral setae. Diameters of anterior eyes of three specimens, 9 to 12, mean 10.3; of posterior eyes, 9 to 10, mean 9.7.

Dorsal setae: Similar in form to those of *E. setosa*. Measurements from four specimens: Length of humerals, 58 to 70; of setae near the middle of the first posthumeral row, 44 to 54; of posterior setae, 35 to 36.

Dorsal formulae for five specimens:

Idaho

Boise County: 2 .. 12 .. 12 .. .. 11 .. 7 .. 2

Montana

Ravalli County: 2 .. 10 .. 11 .. 2 .. 12 .. 8 .. 6 .. 2

2 .. 11 .. 11 .. 1 .. 10 .. 7 .. 4

2 .. 9 .. 11 .. 2 .. 10 .. 6 .. 6

## British Columbia

Kamloops: 2 .. 10 .. 13 .. .. 12 .. 5 .. 4

Ventral setae: Similar to those of *E. setosa*. Data from four specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 36 to 41. Length of first sternals, 44 to 55; of second sternals, 38 to 43; of setae near the middle of the first poststernal row, 29 to 36; of setae in the posterior group, 36 to 41.

MATERIAL: Cotypes of *E. sciuricola* (USNM 892) of *E. americana* (USNM 1277) and specimen from Kamloops, British Columbia, are in U. S. National Museum. Other specimens from Rocky Mountain Laboratory. Specimens from hosts:

<i>Sciurus</i> [= <i>Tamiasciurus</i> ] <i>hudsonicus</i>	<i>Sciurus</i> [= <i>Tamiasciurus</i> ] <i>h. streatori</i>
<i>richardsoni</i>	British Columbia
Montana	Kamloops: July 5, 1936, 1.
Florence: 19 (cotypes <i>E. sciuricola</i> ).	Pine squirrel
Chipmunk	Montana
Idaho	Ravalli County: Dec. 1944, 1.
Boise County: Sept. 20, 1930, 1	<i>Tamiasciurus</i> sp.
(cotype <i>E. americana</i> ).	Montana
	Ravalli County: Aug. 17, 1945, 1;
	Nov. 1945, 1.

SEASONAL DISTRIBUTION: *E. sciuricola* has been collected in July, August, September, and December.

GEOGRAPHIC DISTRIBUTION: *E. sciuricola* has been collected in Idaho, Montana, and British Columbia (fig. 8,a).

DIAGNOSIS: *E. sciuricola* can be distinguished from the other members of the "*blarinae*" group by the following combination of characters: Posterior body setae not leaflike, scutum and free leg segments without punctae, head of sensilla cordiform. It is much like the eastern *E. setosa*, from which it can be distinguished by the cordiform head of its sensilla, by the lack of punctae on its cheliceral base, and by the more distinct dorsal tooth on its cheliceral blade.

REMARKS: The specimens in the U. S. National Museum comprising the cotypes of *E. sciuricola* are badly distorted. The specimens comprising the cotypes of *E. americana* are reasonably distinct. So far as can be determined at this time, there is no essential difference between the two. From the original descriptions the palpal claw might be used as a distinguishing character. The palpal claw of *E. sciuricola* was given as 3-pronged; that of *E. americana* as 5- or 7-pronged. The palpal claw of *E. americana* conforms with the original description. The palpal claw cannot be seen clearly on the cotypes of *E. sciuricola*, but there are indications of five prongs. The type specimens of *E. sciuricola*

were collected from the squirrel, *Tamiasciurus hudsonicus richardsoni*, at Florence, Ravalli County, Mont. Chiggers of this type have been collected subsequently from *Tamiasciurus* sp. in Ravalli County. All have had five or more prongs on the palpal claw. The evidence now available indicates that *E. sciuricola* and *E. americana* are the same species. In Wharton, Jenkins, et al. (1951), the two species are listed as being synonymous. *E. americana* is here considered to be a synonym of *E. sciuricola*.

The single specimen on the slide in the series of cotypes marked "C. E. F. X." is here designated lectotype.

#### 25. *Euschöngastia* sp.

FIGURE 8,a; PLATES 8, 20

DESCRIPTION: Size: Length, 270 to 700; width, 225 to 505.

Shape: Ovoid to broad ovoid; broad oval.

Gnathosoma: Setae generally like those of *E. sciuricola*. Lateral seta on palpal tibia nude. Number of prongs on the palpal claw variable in the five specimens and on the two claws of three specimens; the distribution of prongs on the palpal claws of the five specimens are as follows: Three and three prongs, three and four prongs, three and five prongs, four and four prongs, and four and five prongs. Dorsal tooth on the cheliceral blade farther from the tip of the blade than in *E. sciuricola*. Punctae as in *E. sciuricola*.

Legs: Characters generally as for *E. sciuricola*.

Scutum: Characters generally as for *E. sciuricola*. Posterior margin tends to be more convex; lateral margins tend to be less concave. Setae tend to be heavier. Sensillae rounded at tips.

Summary of standard data of five specimens from Ravalli County, Mont. (AM's and S's for four specimens):

AW 62-72, mean 67.8; PW 91-99, mean 96; AP 17-24, mean 20.8;  
SB 23-29, mean 26.6; ASB 25-31, mean 27.4; PSB 8-15, mean 12.4;  
AL 43-50, mean 47.2; AM 32-41, mean 37; PL 70-76, mean 71.2;  
S 25-28, mean 25.8. Width of head of sensilla in four specimens,  
all 17.

Eyes: Two pairs; anterior pair lateral to the posterolateral setae. Diameters of anterior eyes of three specimens, 12 to 13, mean 12.7; of posterior eyes, 11 to 14, mean 12.3.

Dorsal setae: Generally similar in form to those of *E. setosa*. Somewhat heavier than those of *E. sciuricola* and more numerous. Length of humerals of five specimens, 67 to 72; of setae near the middle of the first posthumeral row, 50 to 57; of setae in the posterior group, 42 to 48.



Dorsal setal formulae for five specimens from Ravalli County, Mont.:

2	..	13	..	12	..	2	..	16	..	8	..	6
2	..	14	..	16	..	..	14	..	8	..	8	.. 4
2	..	14	..	12	..	..	12	..	10	..	6	
2	..	12	..	13	..	2	..	12	..	7	..	6 .. 3
1	..	11	..	12	..	..	12	..	9	..	6	

Note: It could not be determined if the final specimen of the series was anomalous by lacking a humeral seta or if the seta had been lost.

Ventral setae: Similar to those of *E. setosa*. Data from five specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 43 to 50. Length of first sternals, 48 to 57; of second sternals, 38 to 50; of setae near the middle of the first poststernal row, 31 to 36; of setae in the posterior group, 40 to 48.

MATERIAL: All specimens from the Rocky Mountain Laboratory. Specimens from hosts, all from Montana:

*Marmota flaviventris*

Ravalli County: Apr. 18, 1943, 1.

*Marmota f. nosophora*

Ravalli County: May 2, 1945, 2;  
May 10, 1945, 2.

SEASONAL DISTRIBUTION: *Euschöngastia* sp. has been collected in the spring months of April and May.

GEOGRAPHIC DISTRIBUTION: The only known collections of *Euschöngastia* sp. have been made in Ravalli County, Mont. (fig. 8,a).

DIAGNOSIS: Because of uncertainty concerning the position of *Euschöngastia* sp., no diagnosis is given.

REMARKS: The five specimens described here appear to be morphologically distinct. Apparently the form they represent has a host preference for marmots, which further differentiates them. At the same time they exhibit great similarity to *E. sciuricola*, found on squirrels in the same geographic range. Collections of the two forms have been made at different seasons. The history of the five specimens has not been determined. It is not known whether they constitute the total collections of the form from marmots or if they are a sample from larger collections.

Characters by which the five specimens differ from *E. sciuricola* include the number of dorsal setae and the number of prongs on the palpal claw. However, the data for both characters of the two forms can be put together to make continuous series. The highest dorsal setal count of *E. sciuricola* slightly overlaps the lowest count for *Euschöngastia* sp. But when the data for the total number of dorsal setae are put together in this way, the

variation is considerably greater than that usually found in species of *Euschöngastia*. The unusual extent of the variation is easily apparent in the first posthumeral row of setae for the two forms. The lowest count of the number of prongs on the palpal claw of *E. sciuricola* coincides with the highest count determined for *Euschöngastia* sp. When the data for the number of prongs on the palpal claw of the two forms are put together, the range of variation becomes extreme, but it is continuous.

The variation in the number of prongs on the palpal claw of *E. sciuricola* is not remarkable. However, the variation exhibited by the five specimens of *Euschöngastia* sp. has no precedent. The number of prongs on the palpal claw of all other North American *Euschöngastia* is very constant and has been useful in arranging the chiggers into apparent natural groups. The striking variation of the number of prongs on the palpal claw of *Euschöngastia* sp. cannot be explained until a longer series of specimens has been examined.

The sample available at this time is not adequate for making a determination of the position of *Euschöngastia* sp.

### Discussion

A systematist engaged in separating and defining species must have some clear concept of these populations. Any definition which he may develop will be shaped by what he finds in his material and should be more clear the more intimately he knows the material. The many diverse definitions of species with which students are familiar all tend to reflect the varying interests of the authors. It follows that, whatever its scope, the definition of a working systematist must be useful. On these grounds, a species of *Euschöngastia* in this paper is a population of chiggers which conforms to a morphological pattern, normally variable within limits, which is found in a certain ecological pattern within a geographic range, and which is biologically continuous. The morphological pattern of the species can be observed and charted. The ecological pattern, including the distribution of the chiggers before attachment, the host distribution and the localization on hosts during attachment, and the seasonal distribution is determinable. The geographic range can be plotted. Chiggers are not the reproductive stage of the trombiculid life cycle, but their biological continuity is evident in collections of succeeding years. According to this concept, a species of *Euschöngastia* is natural and definable.

Much of the basic work on systematics is concerned with mor-

phology. According to Simpson (1945), "It is not useful to set up a classification in which groups with different names cannot be distinguished morphologically." All species of *Euschöngastia* included in this paper have been defined morphologically. This includes an enumeration of the various features which characterize each species, but it does not imply a static definition. Given a series of specimens sufficiently long, it is doubtful if there is any morphological character which cannot be found to vary. Variability is an expression of the genetics of the species, and is itself a character of the species. An adequate morphological definition should include these variations. However, it is standard practice to identify specimens initially by means of diagnostic or systematic characters, those characters which differ between known species. Use of these practical tools of the systematist saves both time and effort. But these characters are only systematic aids, and a species of *Euschöngastia* is not a "nude lateral seta on the palpal tibia" or a "mastitarsala III." Following a tentative identification on the basis of diagnostic or key characters, the specimen should be compared with the complete description, with other identified specimens, and, when possible, with type material. This final comparison is important in *Euschöngastia*. Undoubtedly, many species remain undescribed.

Study of North American *Euschöngastia* reveals that at present it contains four well-defined groups of species, three somewhat less well-defined groups of species, and four ungrouped species—a total of 24 species (excluding *Euschöngastia* sp.), with one of these divided into two subspecies. These species have certain relationships with each other which can be used to segregate either groups of species or the species themselves.

When attention is given to particular systematic characters, it is found that fundamental cleavages can be made in the genus by use of the specialized, or striated setae of the legs. The value of these setae in descriptions and diagnoses was pointed out by Wharton (1947a). In particular he emphasized the striated setae of the third leg as being important in separating morphological groups of species in the genus *Trombicula*. In *Euschöngastia* these setae have a similar importance. On the clear basis of the presence or absence of the tibiala on the third leg, the genus in North America can be split through the middle, so that each half contains groups of morphologically related species. Also, the presence or absence of other striated leg setae distinguishes definite groups. Thus, the absence of subterminalae and parasubterminalae separates the "*lacerta*" group from all others. The

number of genualae in the first leg separates *E. trigenuala* from the "*pipistrelli-oregonensis-samboni*" group. The striated leg setae have some usefulness at the level of the species. *E. luteodema* is quickly separated from *E. marmotae* by the absence of genualae II and III. The mastitarsala on the third leg of *E. nuñezi* is unique in North American *Euschöngastia*. It might easily be one of the characters of a distinct group.

Another character of basic importance is the number of prongs on the palpal claw. The diagnostic value of this character was first recognized by Ewing (1938). He used it to separate the two genera *Neoschöngastia* and *Euschöngastia*. *Neoschöngastia* was diagnosed as having two or three prongs on the palpal claw; *Euschöngastia* was diagnosed as having more than three prongs. Ewing (1946b) separated *Ascoshöngastia* from *Neoschöngastia*. *Ascoshöngastia* was diagnosed in part as having two or three prongs on the palpal claw. Wharton (1948) rejected Ewing's diagnosis of *Ascoshöngastia* and gave a new diagnosis to *Euschöngastia*. By the new diagnosis certain species with two or three prongs on the palpal claw, formerly placed in *Ascoshöngastia*, were included in *Euschöngastia*, which, as stated above, had been diagnosed originally as having more than three prongs. Since the diagnosis of *Euschöngastia* accepted for this paper is basically Wharton's, it is obvious that the number of prongs on the palpal claw is a systematic character useful in separating groups of species.

Following the fundamental divisions based on the two characters discussed above, a variety of characters are useful. The nonspecialized setae of the gnathosoma, the various leg setae, and the body setae are important. The scutum and the sensillae often are distinctive. Various ornamentations occur consistently in different species. The number of eyes and the development of the eyes are useful in a few instances. Color is helpful, but it cannot be determined from a mounted specimen. Size and shape are subject to change in preservation on slides and can be used in few species. However, color, size, and shape are potentially useful in identification of living material, particularly unengorged specimens.

Differences have been found in the number of setules on the setae of the gnathosoma among the species included in this paper. These setae are recognized by all workers in the genus who include at least some of them in descriptions and diagnoses. In the present study the galeal seta and the lateral seta on the palpal tibia were selected for special consideration. Whenever the num-

ber of setules on either of these setae was charted for a species, the distribution always appeared normal (tables 6, 12-15). The taxonomic importance of these selected setae is shown most clearly in the "*rubra*" group (fig. 6,a,b). In this group each of the four related forms has a characteristic distribution of setules. Determinations of distributions of these sorts must be made on a group basis, but, having been made, the data may be used for the identification of single specimens. Differences can be found in the number of setae on the palpal tarsus, but these are associated with chiggers which are distinct on other grounds.

The feathered setae of the legs have not been considered as systematic characters by most workers. Floch and Abonnenc (1941) enumerated these setae by leg segments for *E. guyanensis*. Wharton (1946) enumerated them by leg segments for *Euschöngastia indica*. His count coincides well with the number of setae found in the "*lacerta*" group and on *E. nuñezi*. These species have eight feathered setae on the tibia of the first leg. All other North American species have seven feathered setae on this segment. Possibly the number of feathered setae on the first tibia will prove diagnostic at the level of groups of species. In *E. guntheri* the two setae on the coxa of the third leg are diagnostic at the level of species. Differences occur in the number of feathered setae on the tarsi of certain species; but accurate determination of this is laborious and is not required at the present time. With the exceptions mentioned, the number of feathered setae on the leg segments of *Euschöngastia* studied are the same.

Acarologists have not used the structure of the feathered setae of the legs of chiggers as a systematic character. Gunther (1940) made brief descriptive statements concerning them in describing new species. Later workers have used only a descriptive term, if the setae were mentioned at all. In the present study the structure of these setae was found to differ considerably between many species while remaining constant within a species. This is in contrast to the general uniformity within the genus of the number of the setae per segment. The structure of these feathered setae is useful as a key character in separating the "*luteodema*" group from the "*criceticola-californica*" group. The very similar *E. criceticola* and *E. californica* themselves can be separated by this character, and it could be used elsewhere.

The arrangement of the dorsal setae into rows is conspicuous and lends itself well to counting. Consequently these setae have been used by most acarologists. Ewing (1937), in discussing the setae, stated that their number probably did not vary within a

species. This statement does not hold in *Euschöngastia*. A series of dorsal formulae for any species shows a range of variation in the number of setae. However, Ewing's observation that the positions of the setae change with engorgement is true within this genus. Varying degrees of engorgement doubtless account for certain variations in the dorsal formulae determined for a species. The effect is most noticeable on the posterior portion of the body which undergoes greatest change during engorgement. The anterior rows are quite distinct in all engorgements. Also, this factor may in part be responsible for the lateral setae. These setae apparently are lateral extensions of the dorsal rows. Their appearance out of line may be the combined result of displacement by engorgement and a flattening of the specimen on the slide. During a large portion of this study, an effort was made to assign the laterals to the rows of dorsals. It can be questioned whether this is the better procedure, since including the setae in the formulae as laterals conforms more closely with the distribution observed on a specimen. Usually the dorsal setae are clearly arranged in rows; and the length of each row conforms somewhat to the diameter of the body where it is found. In some species there are extra setae which may occur out of line. This condition is found in the "*luteodema*" group. It is most strongly developed in *E. guntheri*. In *E. magna* the extra setae occur as short rows between the longer rows. Each species of *Euschöngastia* has a characteristic pattern to its dorsal formula which is a valuable systematic aid.

Differences in structure of the dorsal setae have been recognized by several systematists. Earliest instances occurred when the setae assumed a leaflike shape. On this basis Gunther (1940) and Womersley (1944) used the shape of dorsal setae to distinguish new species. However, Lawrence (1949) determined differences in the more normally shaped body setae of African *Euschöngastia*. He figured both dorsal and ventral body setae for his new species and used the relative thicknesses of dorsal setae as key characters. In the present study these setae have been found to have similar systematic value for North American *Euschöngastia*. The flat, leaflike shape and the distribution of the posterior body setae are diagnostic in *E. carolinensis* and *E. ohioensis*. Within the "*rubra*" group the character is important. Here the setae have normally round shafts, and the difference involves the setules of the posterior setae. The relative size of the setules on the dorsal setae is useful in distinguishing between *E. setosa* and *E. blarinae*. Potentially the structure of the dorsal

body setae is useful in other species. Observation indicates that the structure of the dorsal setae is more constant than their numbers.

The ventral setae, except the sternals, are not easily assignable to rows. Usually they are rather numerous in *Euschöngastia*, and counting them becomes laborious. Some descriptions (Womersley, 1944) list the setae by rows when the number is small. When the number is large, the approximate total number may be given (Wharton, 1948, and Brennan, 1947, 1948). The latter method is used in this paper. Usually the poststernal setae increase in size posteriorly. Brennan (1948) has referred to a difference in form between the setae anterior to the anus and those posterior to the anus, with the posterior setae frequently resembling the dorsal setae. This difference has been found in certain species in the present study, being most clearly shown in *E. nuñezi*. In other species, such as *E. peromysci* and *E. rubra*, the dorsals and all poststernal ventrals have the same form.

The scutum, with its associated setae and sensillae, is a very remarkable structure. It has been much used by all workers in defining and diagnosing species. In *E. nuñezi*, *E. trigenuala*, *E. peromysci*, *E. rubra*, *E. hamiltoni*, and possibly others the outline and markings of the scutum are so distinctive that they alone may serve to diagnose the species. In all species they are characteristic and helpful. The markings usually consist of punctae and ridges. Caution must be exercised in using these structures, since ridges frequently are obscured on wide scuta, such as occur in the "*blarinae*" group, and punctae may be obscured in any species. The sensillae also are distinctive in many species. *E. nuñezi*, *E. criceticola*, and *E. blarinae* are examples. Sensillae are always useful but, regrettably, are often lost. Both length and structure of the scutal setae are useful systematic characters in certain species, such as *E. pipistrelli* and *E. hamiltoni*.

Womersley and Heaslip (1943) introduced the series of measurements known as the standard data of the scutum. These data are an expression of size and proportion of the scutum and as such are useful in systematics. Womersley and Kohls (1947) treated the standard data statistically in describing new species of *Euschöngastia* from New Guinea. In the present study no effort was made to use statistical methods with the data.

From observation of numerous specimens, it seems that the scutum is subject to change or deformation in many species. Particularly in species with wide scuta, larger scuta are associated with well engorged specimens. This is in accord with

Wharton and Hardcastle (1946), who found the scuta of larger specimens of their new species *Neoschöngastia ewingi* were larger than the scuta of unengorged specimens. The scuta also differed in shape. The drawing of the scutum of *E. setosa* (pl. 8,c) was made from a well engorged specimen which was flattened on the slide. It measures 112 microns between the posterolateral setae. This is the largest measurement recorded for a scutum of *E. setosa*. A scutum obviously deformed as a result of preservation on a slide was found in *E. sciuricola*. Wharton and Hardcastle point out that it is clear that changes can occur in the character of the scutum of an individual chigger, and mistakes may result from placing too much emphasis on the standard data. This statement is supported by present observations on the scuta of *Euschöngastia*. Judged in this light, the clinal nature exhibited by the size of the scutum of *E. peromysci* (fig. 5,a) and that of *E. diversa diversa* (fig. 5,c) are not above suspicion. However, the figures referred to (charting this feature for the two species) are included on the basis of the presumed random selection of the specimens represented.

The presence or absence of punctae on the cheliceral base, the palpal coxa and femur, the leg segments, and the scutum may be of systematic value. Lawrence (1949) used the difference in size of scutal punctae as a key character. Differences in size of punctae occur in North American *Euschöngastia* and have been used as diagnostic aids. Usually, however, advantage is taken of the differences in distribution of the punctae. Within certain species the punctae characteristically are present on some parts and absent on others. This aid has been of particular value among certain species of the "*blarinae*" group.

The eyes are of distinct, though limited, systematic value. Most species have two pairs of eyes not held in ocular plates. In *E. pipistrelli*, with its one small and indistinct pair of eyes, the character is important. In *E. trigenuala* the eyes are reduced apparently to one pair, but this species is quite distinct on other criteria. *E. lacerta* and *E. nuñezi* are the only species studied in this work which have ocular plates. Occasionally, in an unengorged specimen of one of the other species, the eyes may be close together and appear to be in an ocular plate.

Differences occur in the size of the teeth on the chelicerae. For example, these are rather large in *E. crateris* and quite small in *E. blarinae*. Usually the dorsal tooth cannot be detected in *E. blarinae*. Differences in the shapes of leg segments occur between



the species. Also, relative lengths of empodium and claws are often characteristic. These characters are included in the descriptions. At the present time it is not necessary to use them in diagnoses.

The method used in this paper to illustrate the descriptions of species of chiggers logically follows the method of study. Wharton (1947a) reported a shorthand system of taking notes on chiggers by making a series of drawings of morphological details. His method was used during the present study and was adapted for the illustrations in this paper. It represents a departure from the usual methods of authors. For example, Gunther (1940) drew the scutum, the cheliceral blade, and longitudinal halves of the dorsum and venter. Womersley (1944) also drew the scutum, but he included a ventral view of the gnathosoma, a dorsal view of the tarsus of the first leg, and full views of the dorsum and venter. Brennan (1948) included drawings of the scutum and longitudinal halves of the dorsum and the venter; in addition he illustrated a longitudinal, dorsal half of the gnathosoma. In the present paper the drawing of the scutum has been included; but almost all the other drawings of earlier authors have been omitted. There is little variation in the general organization of the body in species of *Euschöngastia*. The arrangement of the parts of the body is shown in figures 1 and 2. Such drawings have not been repeated for the species. Drawings of the dorsum and venter frequently do little more than show the number of setae and have been omitted. However, reflecting the emphasis in this paper placed on structures of the gnathosoma and the legs, a whole series of drawings illustrating details of these parts has been included. The drawings present the chigger in a highly dissected manner, but they are the direct result of giving attention to the whole mite rather than to a few restricted features. When the gnathosoma and the legs were included in the study, the higher magnifications of oil immersion lenses became necessary to study these features in detail. With such a method of study, the field of view is reduced and attention is given successively to separate small units. The present system of illustrating the descriptions was adopted as a practical method of presenting the characters on a scale sufficiently large to be useful.

Recently, photomicrography has been used as an aid to the study of the systematics of chiggers. Gill and Parrish (1945) gave directions for photographing the scuta of chiggers by using oblique light from the condenser to outline the structures more sharply. The method was employed by Brennan (1948) to obtain

photographs with which he very effectively supplemented his descriptions and his drawings. These photographs make possible a visualization which cannot be achieved through written descriptions or drawings. Also, by use of such photographs, the acarologist can approach, as closely as is possible, his desire to observe and compare specimens side by side, after the manner of the mammalogist. In the present work photography has been used as a systematic aid in a manner similar to that used by Brennan, although the phase microscope was substituted for the technique of oblique light.

Geography follows morphology in importance in the practical study of systematics. Wallace (1880) said, "Each species is moreover usually limited to one continuous area. . . ." Thus, the geographic range may be used as a check on the morphological species. There is no literature on the geographic distribution of North American *Euschöngastia* beyond the locality records accompanying the original descriptions of species. Collections remain meager. Through wide areas (fig. 8, *b*) records are completely lacking. The ranges, therefore, are incompletely known, but in every case where the range of a species has been charted a logical geographic area has been indicated (figs. 4, 7, 8). Whenever the range is at all extensive, such as that of *E. pipistrelli*, *E. peromysci*, or *E. setosa*, a few intermediate collections point toward continuity of range.

Further, chiggers of the genus *Euschöngastia* have been collected extensively in the West in a few counties of Montana and Idaho. In the East extensive collections have been made over much of Pennsylvania and a few counties of Ohio and North Carolina. The species collected in each region have been distinctive. Due regard must be given to the blank spaces on the map (fig. 8, *b*), but no eastern species has been reported from the West. No western species has been collected in the East. However, at this time the evidence by no means permits any real delimiting of ranges for any species. *E. pipistrelli*, *E. peromysci*, and *E. diversa diversa* have the greatest extent of range from east to west known at present. But the westward limits may reflect merely the lack of collectors. Purely as an aid to study, species which for the present may be regarded as eastern include *E. pipistrelli*, *E. peromysci*, *E. rubra*, *E. magna*, *E. diversa diversa*, *E. diversa acuta*, *E. marmotae*, *E. hamiltoni*, *E. blarinae*, *E. carolinensis*, *E. crateris*, *E. ohioensis*, and *E. setosa*. Species which may be regarded as western include *E. lacerta*, *E. bigenuala*, *E. oregonensis*, *E. samboni*, *E. cordiremus*, *E. guntheri*,

*E. criceticola*, *E. californica*, *E. luteodema*, and *E. sciuricola*. The Mexican *E. nuñezi* is omitted from the list. Also omitted is *E. trigenuala*, since its locality is not known with certainty.

The importance of geography in the "*rubra*" group with its subspecies has already been discussed in the remarks accompanying the group. Reference has been made to the combined characters of morphology and geographic range in separating the southern *E. carolinensis* from the northern *E. ohioensis*. Available information indicates that each species of *Euschöngastia* has a definite geographic range. The range when known becomes a part of the species definition and a very useful systematic character.

Another phenomenon which follows from a study of the geographic distribution of a species is that of geographic variation. This implies the variations which occur in the characters of a species over its geographic range. Such variations were found and noted for characters of *E. pipistrelli*, *E. peromysci*, and *E. diversa diversa*. When the length of the palpal claw (fig. 5,b), the number of setules on the galeal setae (table 6), and the size of the scutum (fig. 5,a) were charted for *E. peromysci*, the characters were found to vary in each locality and between different localities. The same result was had when the size of the scutum of *E. diversa diversa* (fig. 5,c) was charted geographically. Moreover, when the variations of all these characters were arranged in a continuous gradient, some correlation with geographic direction became evident. In all cases the pattern of variability was the same, generally continuing from west to east, or from south and west to north and east. Huxley (1940) discussed such geographically correlated character-gradients. He termed them "clines" and pointed to their value in summarizing variations and in studying subspecific groupings. In the present paper they have been used only for their value in summarizing geographic variations in the characters of the species.

Information is not adequate for an evaluation of seasonal distribution of the species of *Euschöngastia* with regard to their systematics. From the records available it appears that different distributional patterns may be represented. The charted record of *E. rubra* (fig. 6,d) shows that it occurs on hosts only during the winter and spring. The known record of all the "*rubra*" group falls in this pattern. The record of *E. peromysci* (fig. 6,c) shows that it has a peak incidence on hosts during winter and spring, but it also occurs in smaller numbers during summer and fall. *E. luteodema*, *E. marmotae*, and *Euschöngastia* sp., which

occur on marmots, have been collected only in spring and summer. *E. blarinae*, *E. carolinensis*, *E. crateris*, *E. ohioensis*, and *E. pipistrelli* appear to be active at all seasons. There is obvious diagnostic value in a seasonal distribution such as that of *E. rubra* in which the species is restricted to certain months of the year. However, further collections, particularly of the sort that are made around the year in relatively restricted localities, should be available before determinations of the systematic value of seasonal distributions are attempted.

The systematic significance of the ecology of North American *Euschöngastia* can be discussed only in an introductory manner. Ecological information for the eastern species is fragmentary. Nothing is known of the western species beyond the information on the slide labels. Almost nothing has been done with the free-living stages, including the chigger itself before attachment. However, it was on the basis of ecology that Ewing (1929d) separated the vertebrate-infesting trombiculids from the arthropod-infesting trombiculids. Indications of differences in ecology are contained in the results of collections at a standing dead oak stub (pl. 2) and in the region of an andropogon field (pl. 3) in Duke Forest. It is to be anticipated that acarologists will use the data of ecology to diagnose at the level of species as the information is acquired.

Although this paper is concerned only with the parasitic chiggers, it is important in any discussion of the ecology of these mites to remember that the other stages of the trombiculid life cycle are not parasitic. Disregarding the physical factors of the environment, the trombiculid life cycle demands food in the form of suitable arthropod eggs or tissues during the nymphal and adult stages. Hosts are necessary for the larvae, or chiggers, during the parasitic stage. Since the larvae obviously cannot move far from the locality in which the adults reproduce, it follows that this locality must lie within the range of suitable hosts.

The ecological niches of the free-living stages of *Euschöngastia* remain almost unexplored. The preliminary investigations in the Duke Forest area were generally inconclusive so far as characters of systematic importance are concerned. There is some evidence that free-living *E. peromysci* are associated with well-decayed stumps. There is negative evidence that the niches of the other species were not found. Wharton's (1946) discovery of the free-living stages of *E. indica* in the nests of its host suggests a possibility for North American species, but nests occupied by the common hosts were not found during the present study. Further,

no adequate information of taxonomic significance has been derived from the larger habitat situations. Most species appear to be associated with forests. *E. diversa* seems to be associated with meadows or thickets. *E. blarinae* appears to be independent of any particular cover type and occurs wherever shrews are found. From the host records it might be inferred that certain species, such as *E. marmotae* or *E. pipistrelli*, have a different ecology. However, available information concerning habitats is too general for use in diagnosing species.

When the hosts of the *Euschöngastia* included in this paper are considered, it is found that the chiggers usually parasitize small mammals. Only *E. nuñezi* has been found on birds (fowls). Only *E. lacerta* has been collected from a cold-blooded host. When host relationships are considered more closely for those species which have been collected a number of times, certain host patterns become apparent. Occasionally there seems to be some host preference. One large group of chiggers is found on two or more of the smaller rodents—*Peromyscus*, *Clethrionomys*, *Synaptomys*, and others. These chiggers include *E. peromysci*, *E. cordiremus*, *E. rubra*, *E. magna*, *E. criceticola*, *E. ohioensis*, *E. crateris*, *E. carolinensis*, and *E. setosa*. *Euschöngastia diversa* also is found on smaller rodents, but the list differs to include *Microtus*, *Zapus*, and *Napeozapus* as important hosts, perhaps reflecting a difference in habitat. Another group of species is found on the large rodent, *Marmota*. These chiggers include *E. luteodema*, *E. marmotae*, and *Euschöngastia* sp. *E. sciuricola* has been collected from chipmunks and squirrels. *E. pipistrelli* and *E. hamiltoni* have been found only on bats. *E. blarinae*, except for the type specimen, has been collected entirely from shrews. These differences in host distribution seem to have diagnostic importance, although records are insufficient for comprehensive statements. At the present time it seems that *E. blarinae* can be separated from the similar *E. setosa* on the basis of the host record; but, because of the peculiar status of the type specimen of *E. blarinae*, morphology should always be included in this diagnosis.

Certain problems involving host relationships have already been discussed. These include the case of the type specimen of *E. blarinae*, the host relationships of the similar *E. carolinensis* and *E. ohioensis*, and the correlation of morphology with host preference of *E. luteodema* and *E. marmotae*. The host difference between *E. sciuricola* and *Euschöngastia* sp. has been considered. It was, in fact, the host difference—the one, arboreal; the other,

fossorial—which sharpened the suspicion aroused by the morphological differences between these forms. As a result, *Euschöngastia* sp. is being held for further study.

In addition to the host record of a chigger, it is important to systematics to know as much as possible of the nature of the host-parasite relationship. It has been indicated that the separate ecologies of the host and the chigger must somewhere coincide. The systematist is better able to evaluate the host record if he knows to what degree a chigger is host-specific and to what degree its ecology assists or prevents its meeting certain hosts. Wharton (1946) working with *E. indica* on Guam, found the free-living stages in the arboreal nests of *Rattus mindanensis*. These rats were the only hosts found to be parasitized by the chiggers. Largely on the basis of previous experience with *E. indica*, Wharton inclined to the opinion that proximity was the more important factor in this parasitism. However, he was unable experimentally to infest *Rattus exulans* and *Mus musculus*—two ground-dwelling rodents found in the area—as well as guinea pigs and chickens. He did infest *Rattus mindanensis*. From these results he felt that host distribution was conditioned also by peculiarities of host and parasite. Lawrence (1949) was unable to affirm host-specificity for African trombiculids on mammals. He stated that some appeared to be host-specific, but this could have been the result of too few collections. In the present investigations only *E. peromysci* was used experimentally. *E. peromysci* has a wide range of hosts. Its lack of host specificity was confirmed in the laboratory. It attached to the skin of a man. It engorged on white mice. Further, no species of *Euschöngastia* which has been collected a number of times has been found specific for a single host species. From this it seems quite possible that apparent host preference is but the reflection of the ecology of the free-living stages which places the chiggers in close spatial relationship with particular hosts.

However, as Wharton (1946) found, certain peculiarities of chigger and host may influence distribution. *E. blarinae*, for which a fairly long host record is available, seems to have a host preference for shrews. In Duke Forest unattached *E. blarinae* was collected—although never in large numbers—in combination with *E. peromysci*, which commonly attaches to *Peromyscus leucopus*. The sites were obviously available to *P. leucopus*. Yet, no *E. blarinae* was collected from this mouse. Also, the ubiquitous and nonhost-specific *E. peromysci*, found abundantly on *Peromyscus leucopus* in Duke Forest, was not taken from shrews in

the same area. There are only three records of *E. peromysci* from shrews in other areas. It seems obvious that the spatial relationships involved here could not be very great, and the record shows that unattached chiggers of the two species do mingle. It is possible that some character of host or parasite is operative in these cases to inhibit the shrew-*peromysci* and the mouse-*blarinae* associations.

Records are incomplete with regard to areas infested on hosts, but there are indications that useful characters can be determined. The "*rubra*" group and *E. peromysci* have been recorded only from the external auditory canal or deep in the ears of their hosts. *E. rubra* and *E. peromysci* commonly infest these areas in the ears of *Peromyscus leucopus*. In contrast, *E. crateris* is found in small craters on the edges and the distal surfaces of the ears of *P. leucopus*. On the same host, *E. ohioensis* is found attached around the anal area, with some records having it distributed over the abdomen, back, and legs. In these cases different species of chiggers attach to different areas of a single host species. It would seem that some character of the chigger is involved in determining the region of attachment, which then becomes useful in systematics. Another case concerns *E. blarinae*, which during this study has been found attached only in craters over the posterior portion of the body of *Blarina*. However, collectors have reported it from the folds of the pinna of *Sorex*. Superficially, this might indicate that the areas of attachment involve some characteristic of the host rather than of the parasite. But collectors have recorded *Trombicula jamesoni* Brennan, 1948, from the ears of *Blarina*. This contrasts with the areas observed to be infested by *E. blarinae* on the same host and points to characteristics of the chiggers as determining areas of attachment. In one of the two records of *E. peromysci* from *Blarina*, the collector listed the area of attachment. The chiggers were recorded from the ears. However, *E. blarinae* also was represented in the collection. The study is thus further complicated by the occurrence of more than one species of chigger on a single host. This factor must be recognized whenever any host-parasite relationship is being considered as a systematic character and due precautions must be taken to avoid error. It is interesting that Lawrence (1949) reports that *E. crocidurae* in Africa is found in pits in the skin of its host shrew. Further observation and study are necessary in order to determine the systematic value of the areas of attachment.

It is apparent, even with the scanty information available, that

variations in relation to the environment do exist among species of *Euschöngastia*. But it is equally apparent that ecological definitions and diagnoses are neither easily nor quickly acquired.

No information of value in systematics was derived from the extensive efforts to culture species of *Euschöngastia*. That portion of the trombiculid life cycle from unattached chigger, through engorgement, the detached chigger, and the nympho-chrysalis to the nymph was confirmed in the genus.

Finally, following separation and definition of the species on the basis of the available material, it might be well to consider in summary fashion the biological relationships of the species in the genus. According to Simpson (1945), "The genus tends . . . to be defined as a group of species possessing certain characters in common." Thorpe (1940) discussed briefly the impracticability of defining genera on other grounds. In giving the limits of the genus, Thorpe said, "For practical reasons the genus . . . must in general be neither too large nor too small." The genus, then, tends to be subjective. However, it is subjective only with respect to the definition of its limits, because groups of similar species do have an objectivity in nature, although the total array of species in the genus may not make up a morphological continuum from one form to the next.

Further, if similarly of morphology is evidence of relationship, the genus in North America is not merely an assemblage of species. It does, however, have at least three biological divisions. One of these is represented by *E. nuñezi* alone. This species, with the mastitarsala on the third leg, the nude pointed seta on the palpal tarsus, the two-pronged palpal claw, and unique scutum and sensillae, stands apart from all other species included in this paper. A second division is the "*lacerta*" group. This group of small mites, lacking the subterminala and the parasubterminala on the first leg, with a reduced number of setae on the palpal tarsus, with fine setae and setules on all parts, and with the proximal placement of the seta on the coxa of the third leg, is distinct. The remainder of the species comprise a third, general, broad division with *E. trigenuala* not well fitted in. This division contrasts in its morphology with the characters itemized for the first two. With regard to geographic distribution of these divisions, it can only be said that nothing inconsistent is apparent at present. On the other hand, the distributions are too insufficiently known to be discussed.

The third division includes several morphological groups which have been outlined in this paper for practical purposes. Closer



relationship is not necessarily implied in these groupings. But, to quote Simpson again, "Similar animals living in adjacent areas are likely to be more closely related than animals, even equally similar animals, widely separated . . . in fact, animals clearly cannot have common ancestry without also having common geographic origin." On this basis the forms within the "*rubra*" group are obviously related. The species of the "*blarinae*" group, excepting possibly *E. sciuricola*, appear to be related, with *E. carolinensis* and *E. ohioensis* having closer affinities. However, not enough is known of the species and their distributions to attempt any further genetic groups.

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## Explanation of plates 9-21

Details of appendages of species of *Euschöngastia*PLATE 9.—*E. lacerta* and *E. bigenuala*

Left: *Euschöngastia lacerta*. Segments of palp and legs are indicated by number. Setae of each segment are shown. A figure within parentheses indicates the number of feathered setae on the segment. A seta not in parentheses occurs alone on the segment. Striated setae follow feathered setae in the illustrations. Striated setae of the legs are sketched on the segments. The segments of the palp are: 1, coxa; 2, femur; 3, genu; 4, tibia; and 5, tarsus. Illustrations of the tibia show the dorsal seta, lateral seta, ventral seta, and the palpal claw, in that order. The pairs of legs are numbered, anterior to posterior, I, II, and III. The segments of the legs are: 1, coxa; 2, trochanter; 3, basifemur; 4, telofemur; 5, genu; 6, tibia; and 7, tarsus. The coxa of leg III is shown with seta attached. Claws and empodium of leg III are illustrated. Cheliceral blade is shown in dorsolateral view, dorsal tooth exposed. All legs illustrated are from the right side of the specimen.

Right: *Euschöngastia bigenuala*. Leg I from left side of specimen; legs II and III from right side. Segments 6 and 7 of leg II sketched dorsal surface down, as they appeared on the specimen. See above for explanation of general organization of drawings.

PLATE 10.—*E. trigenuala* and *E. nuñezi*

Left: *Euschöngastia trigenuala*. Cheliceral blade partly covered by cheliceral base. Drawings of two palpal claws, showing variation. Legs I and III from the right side of the body. Leg II from the left side. Several specimens from the type series were used for the drawings.

Right: *Euschöngastia nuñezi*. On palp 5 in this species is an extra, pointed seta. Blade missing from chelicera. Segment 7 of leg III with a mastitarsala. All legs from the right side of the body.

Refer to explanation of plate 9 for general organization of drawings.

PLATE 11.—*E. oregonensis* and *E. pipistrelli*

Left: *Euschöngastia oregonensis*. Cheliceral blade partly covered by cheliceral base. All legs from right side of body. Drawings from a cotype.

Right: *Euschöngastia pipistrelli*. Medial view of blade of chelicera, teeth concealed. All legs from right side of body.

Refer to explanation of plate 9 for general organization of drawings.

PLATE 12.—*E. cordiremus* and *E. peromysci*

Left: *Euschöngastia cordiremus*. Lateral view of blade of chelicera, teeth exposed. All legs from the right side of the body. Drawings from a paratype.

Right: *Euschöngastia peromysci*. Base of chelicera badly crushed on the specimen and omitted from the drawing. All legs from the right side of the specimen. Drawings from holotype.

Refer to explanation of plate 9 for general organization of drawings.

PLATE 13.—*E. rubra* and *E. magna*

Left: *Euschöngastia rubra*. Leg I from left side of specimen. Legs II and III from right side.

Right: *Euschöngastia magna*. All legs from right side of specimen.

Refer to explanation of plate 9 for general organization of drawings.

PLATE 14.—*E. diversa diversa* and *E. diversa acuta*

Left: *Euschöngastia diversa diversa*. Medial view of blade of chelicera, subapical teeth not visible. All legs from right side of specimen.

Right: *Euschöngastia diversa acuta*. Medial view of blade of chelicera, dorsal tooth barely visible. Leg I from left side of specimen. Legs II and III from right side of specimen.

Refer to explanation of plate 9 for general organization of drawings.

PLATE 15.—*E. guntheri* and *E. criceticola*

Left: *Euschöngastia guntheri*. All legs from right side of specimen.

Right: *Euschöngastia criceticola*. All legs from right side of specimen.

Refer to explanation of plate 9 for general organization of drawings.

PLATE 16.—*E. californica* and *E. marmotae*

Left: *Euschöngastia californica*. Setae on palpal coxa and tarsus not determined. Outline of tarsus I not determined. All legs from right side of specimen.

Right: *Euschöngastia marmotae*. Legs I and II from left side of specimen. Leg III from right side of specimen.

Refer to explanation of plate 9 for general organization of drawings.

PLATE 17.—*E. hamiltoni* and *E. luteodema*

Left: *Euschöngastia hamiltoni*. Legs I and III from right side of specimen. Leg II from left side.

Right: *Euschöngastia luteodema*. All legs from right side of specimen.

Refer to explanation of plate 9 for general organization of drawings.

PLATE 18.—*E. blarinae* and *E. setosa*

Left: *Euschöngastia blarinae*. All legs from right side of specimen. Slope on antero-distal margin of coxa III somewhat atypical; usually about parallel to posterior margin. Palpal claw more slender than usual.

Right: *Euschöngastia setosa*. All legs from right side of specimen.

Refer to explanation of plate 9 for general organization of drawings.

PLATE 19.—*E. crateris* and *E. carolinensis*

Left: *Euschöngastia crateris*. Drawings of both palpal claws of specimen included, showing variation. Drawings of both galeal setae included. All legs from right side of specimen.

Right: *Euschöngastia carolinensis*. All legs from right side of specimen.

Refer to explanation of plate 9 for general organization of drawings.



PLATE 20.—*E. samboni* and *Euschöngastia* sp.

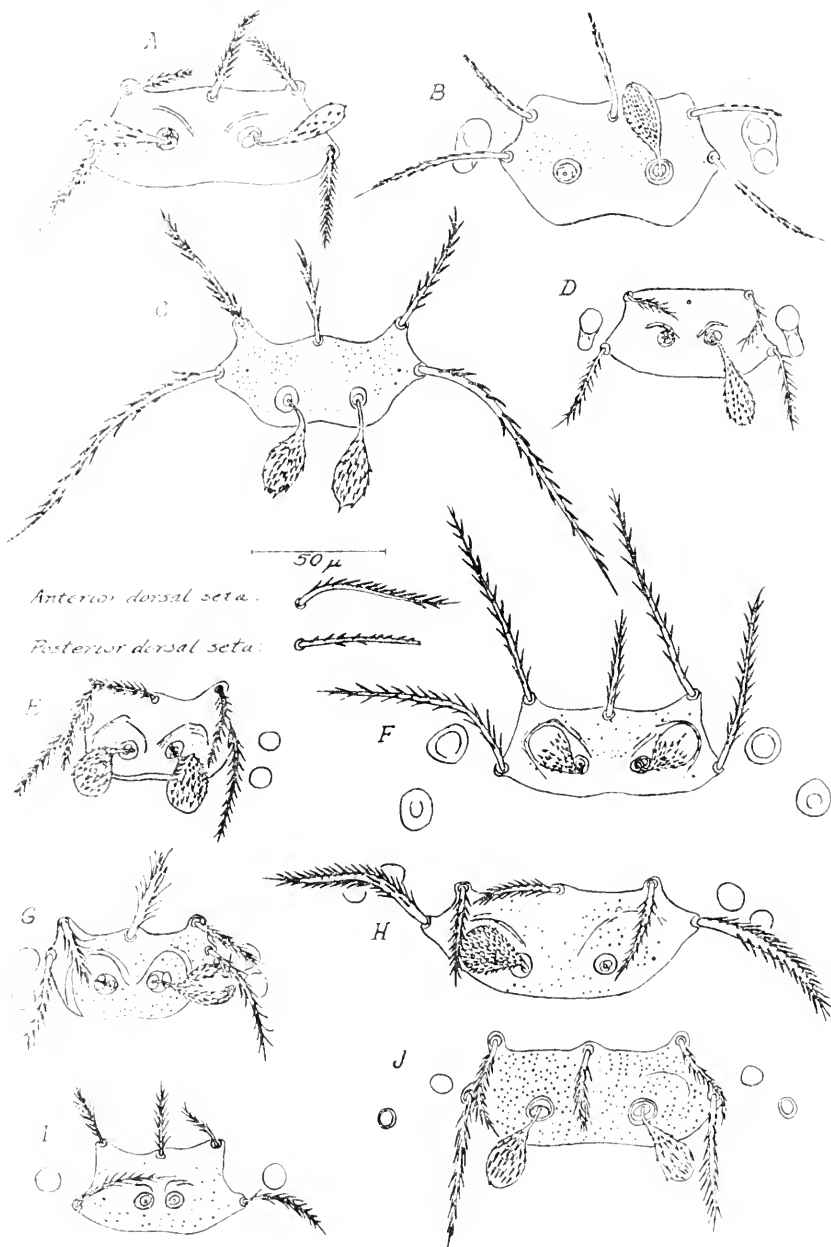
Left: *Euschöngastia samboni*. Leg I from left side of body. Legs II and III from right side. Drawings from a paratype.

Right: *Euschöngastia* sp. Drawings of both palpal claws included, showing variation. All legs from right side of specimen.

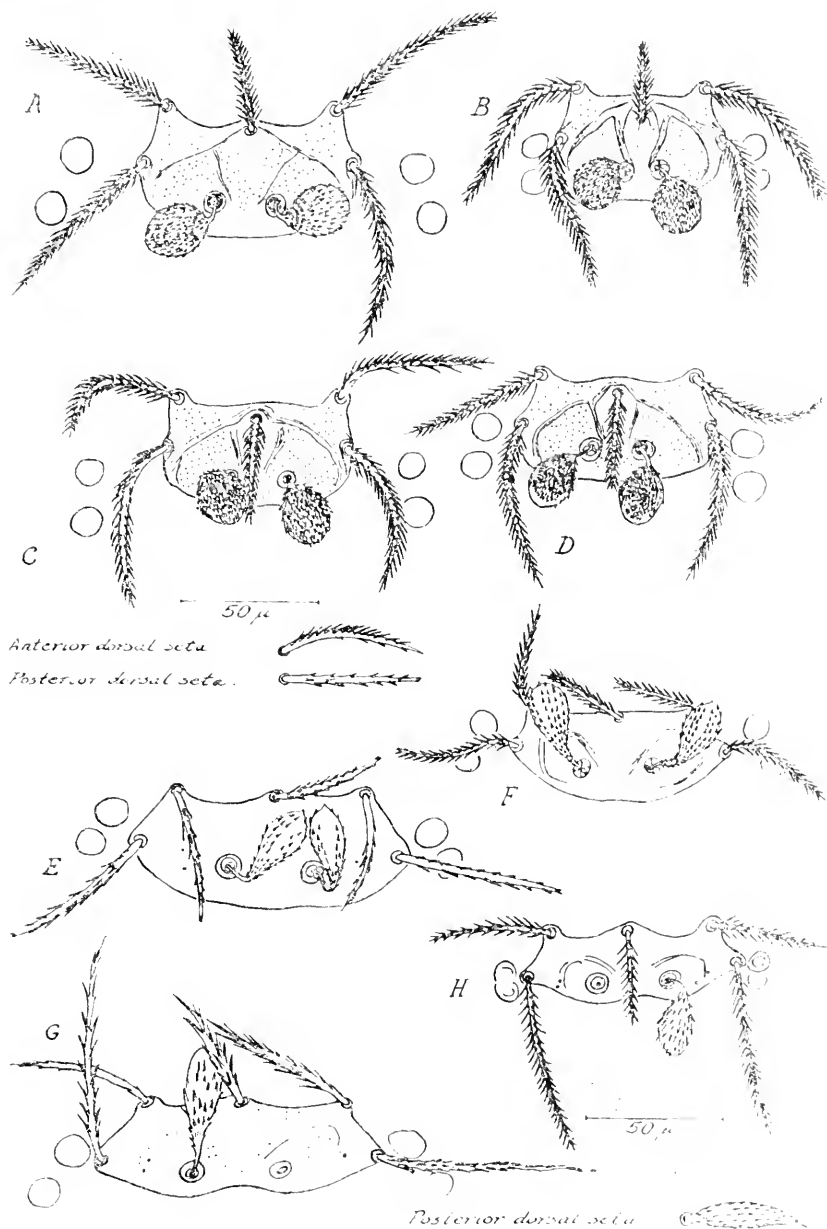
Refer to explanation of plate 9 for general organization of drawings.

PLATE 21.—*E. sciuricola*

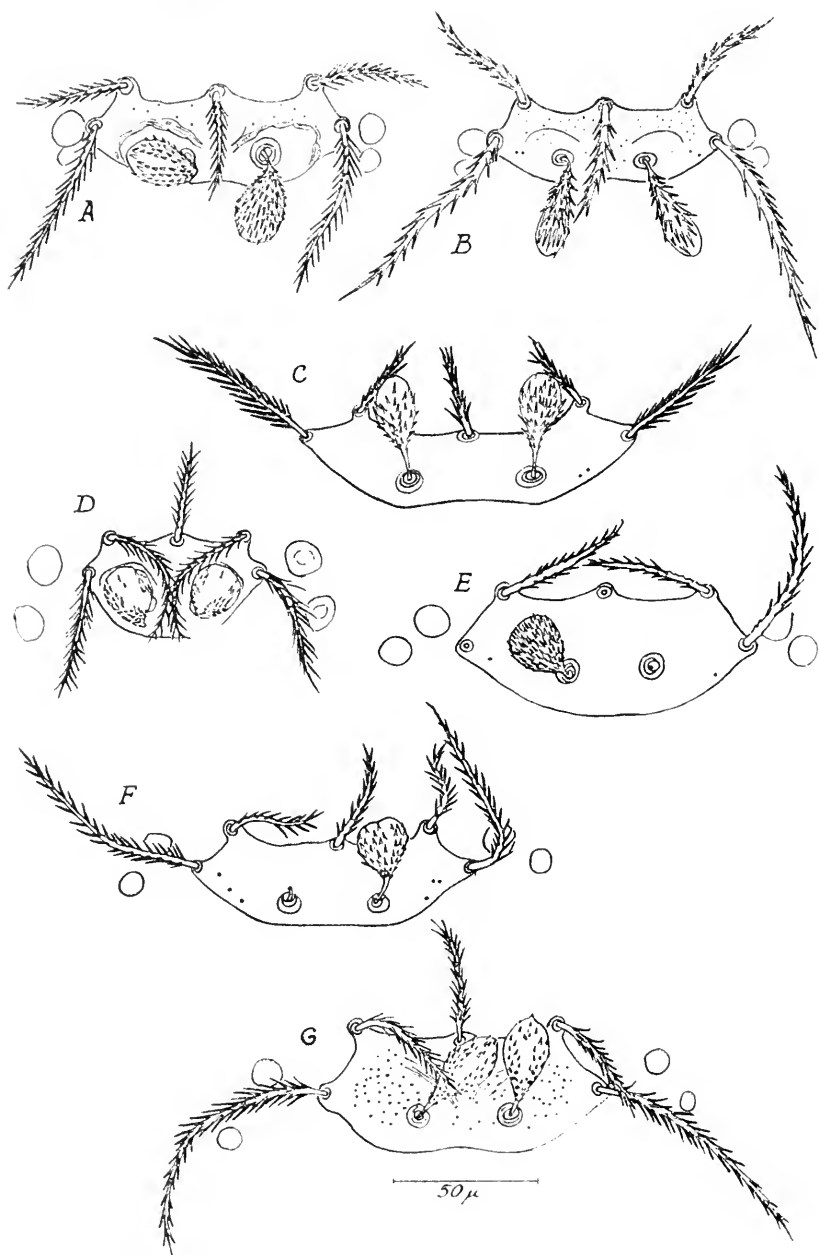
*Euschöngastia sciuricola*. Leg I from left side of specimen. Legs II and III from right side. Refer to explanation of plate 9 for general organization of drawings.



Scutum and eyes (except A and C) of: A, *Euschöngastia trigenua*; B, *E. nuñezi*; C, *E. pipistrelli* (including dorsal body setae); D, *E. lacerta*; E, *E. peromysci*; F, *E. hamiltoni*; G, *E. cordiremus*; H, *E. guntheri*; I, *E. bigenua*; and J, *E. oregonensis*.

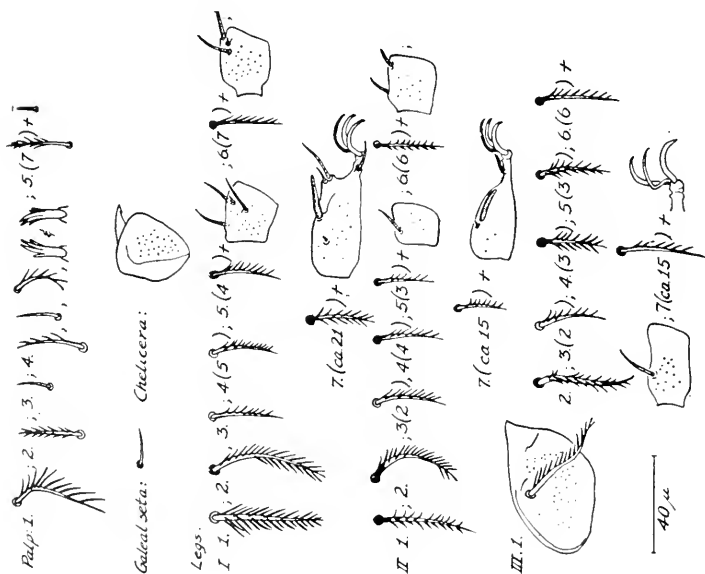
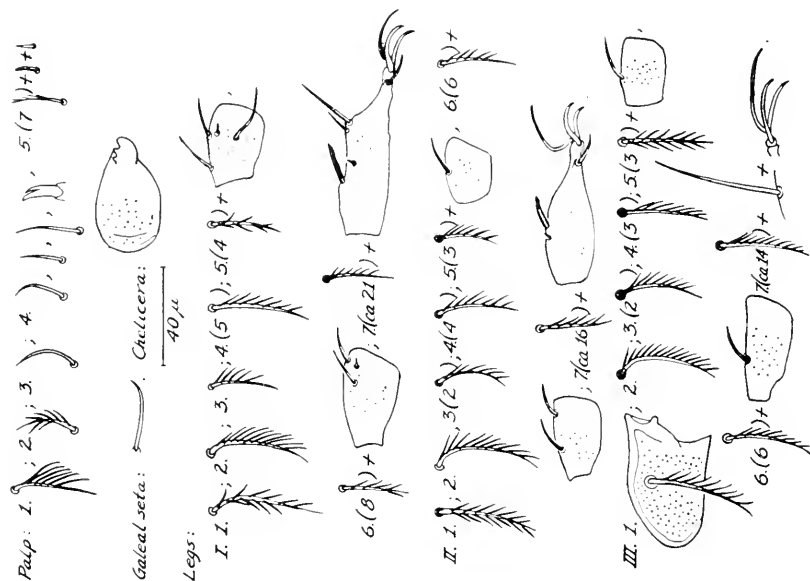


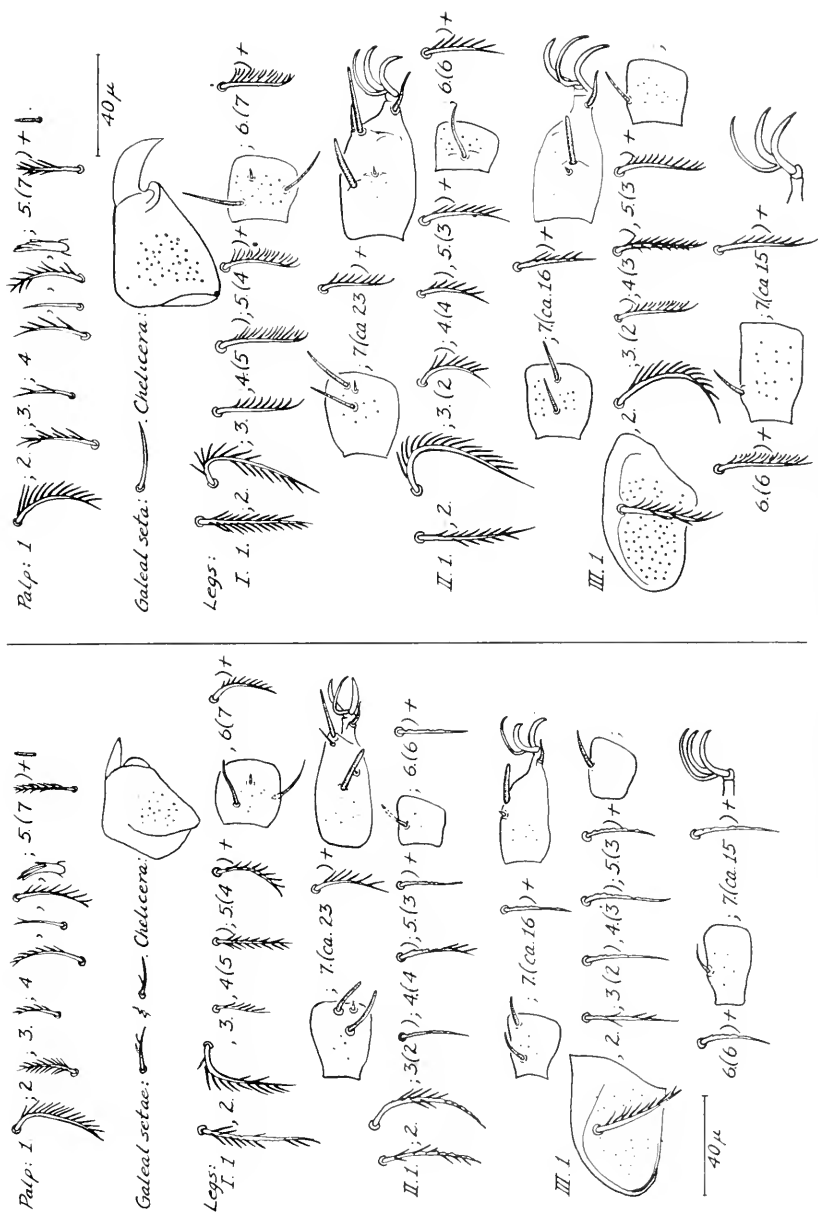
Scutum and eyes of: A, *Euschöngastia magna*; B, *E. rubra*; C, *E. diversa diversa* (including dorsal body setae); D, *E. diversa acuta*; E, *E. luteodema*; F, *E. criceticola*; G, *E. marmotae*; and H, *E. carolinensis* (including a posterior dorsal body seta).



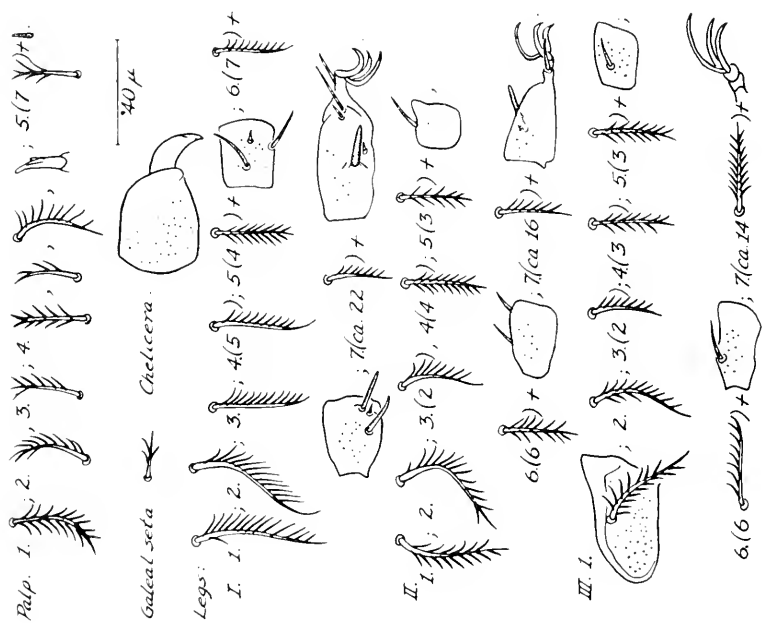
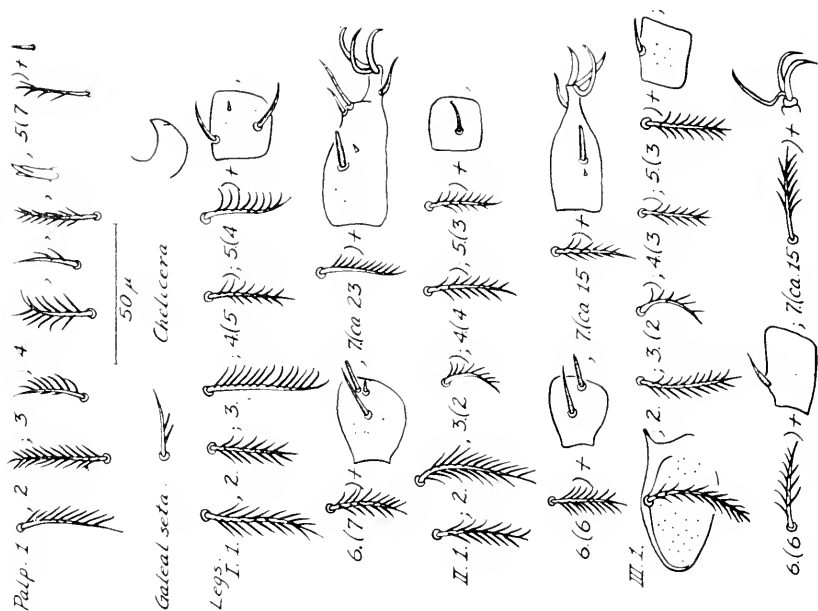
Scutum and eyes (except C) of: *Euschöngastia crateris*; B, *E. blarinae*; C, *E. setosa*; D, *E. californica*; E, *Euschöngastia* sp.; F, *E. sciuricola*; and G, *E. samboni*.





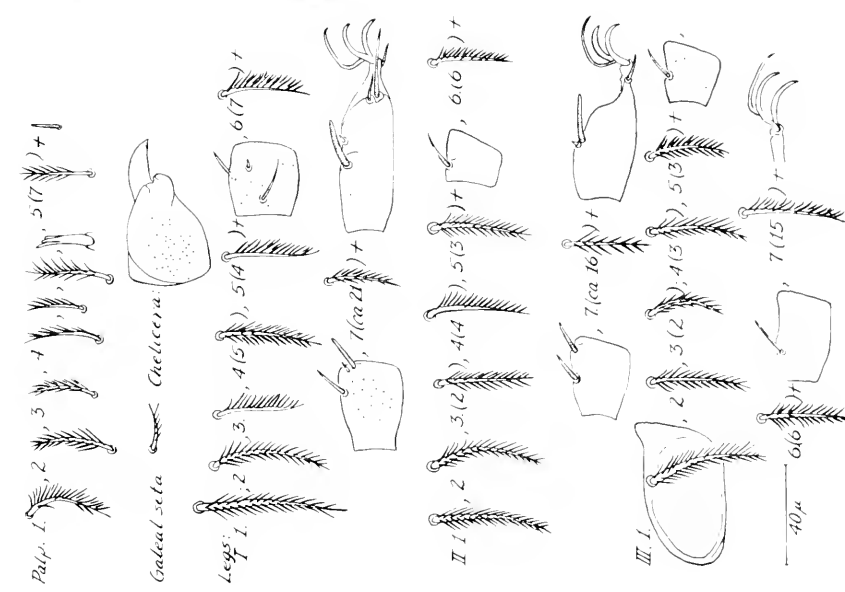
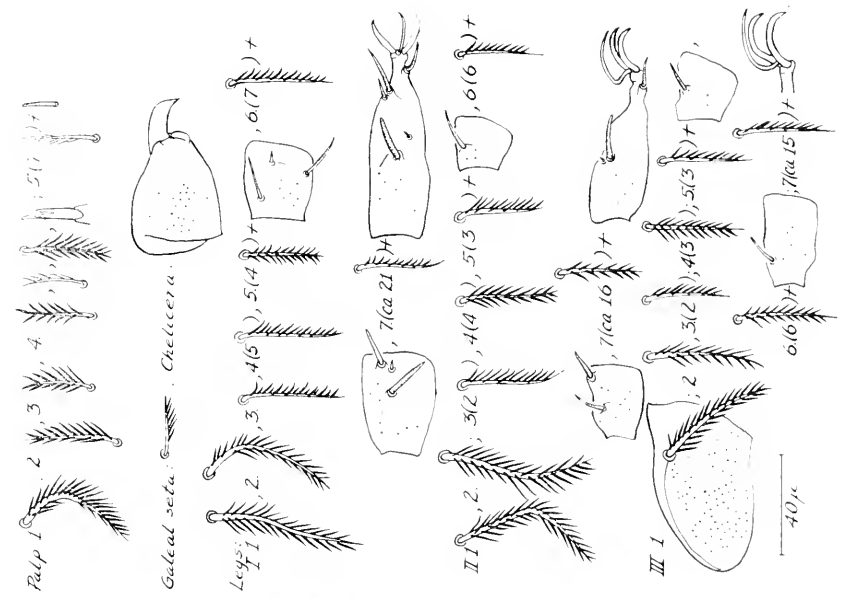


*Euschingastia oregonensis* and *E. pipistrelli*. Explanation on page 233.

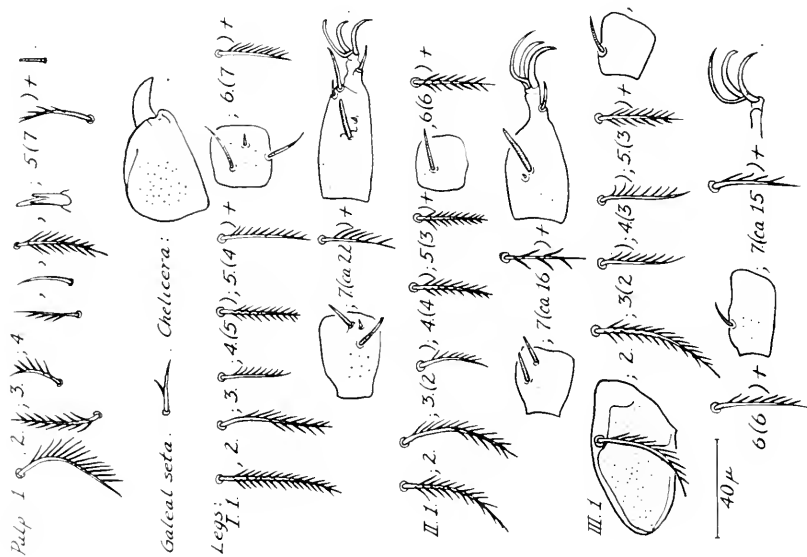
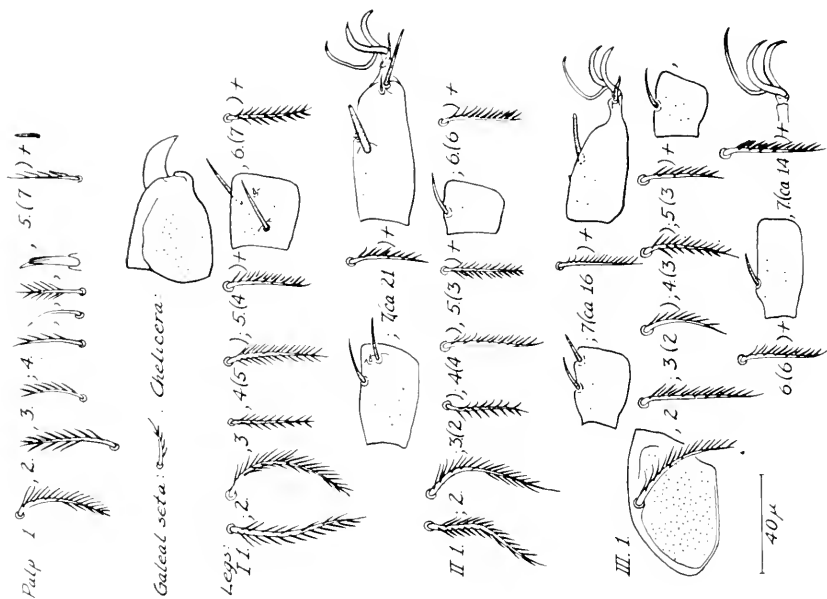


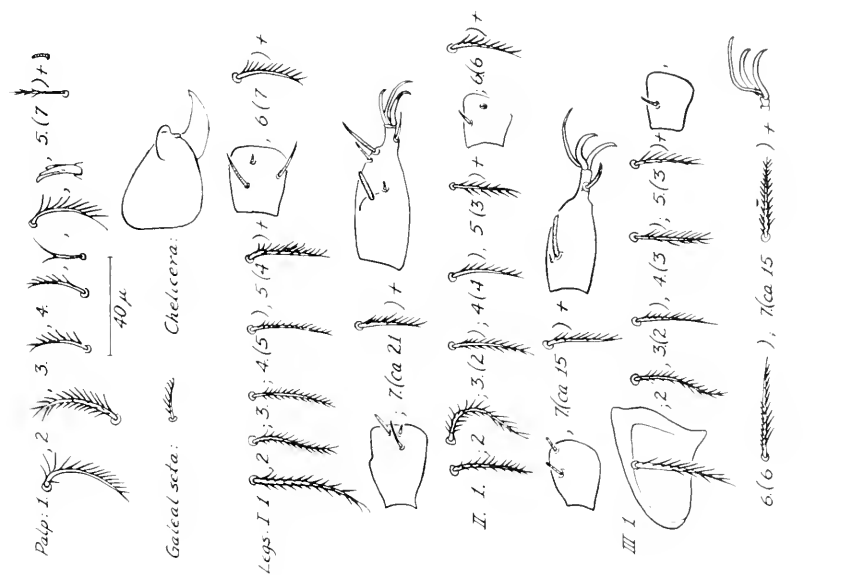
*Euschöngastia cordiremus* and *E. peromysci*. Explanation on page 233.



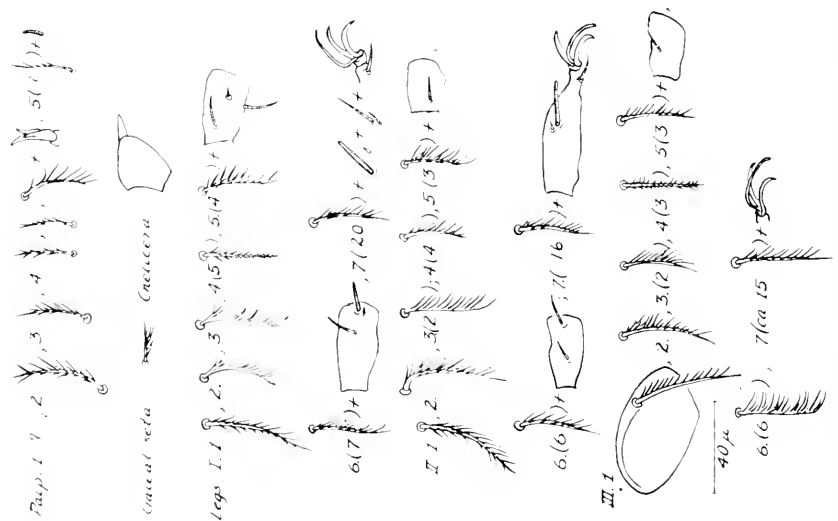
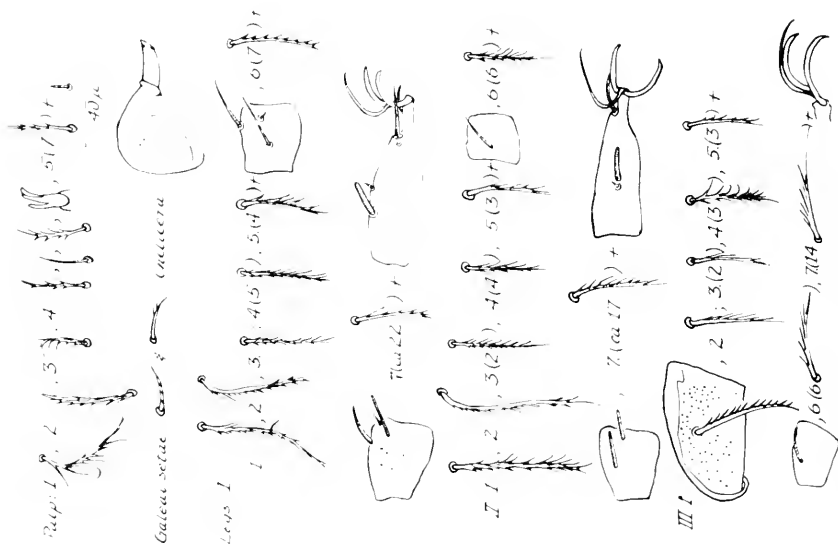


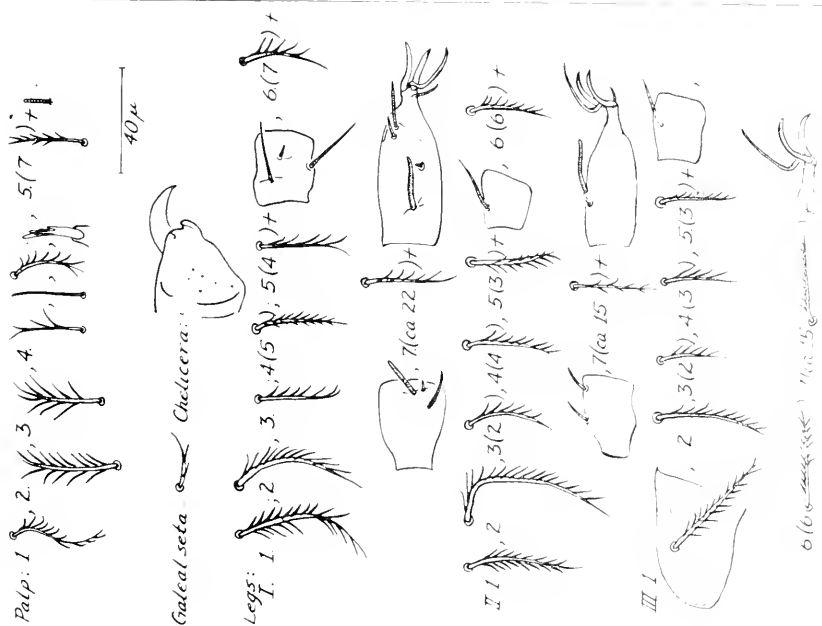
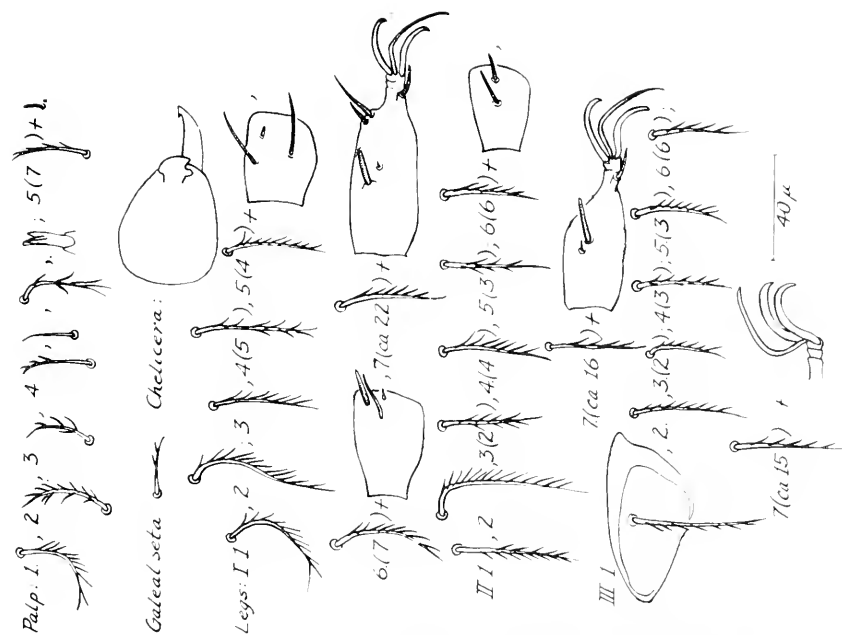
*Euschongastia rubra* and *E. magna*. Explanation on page 234





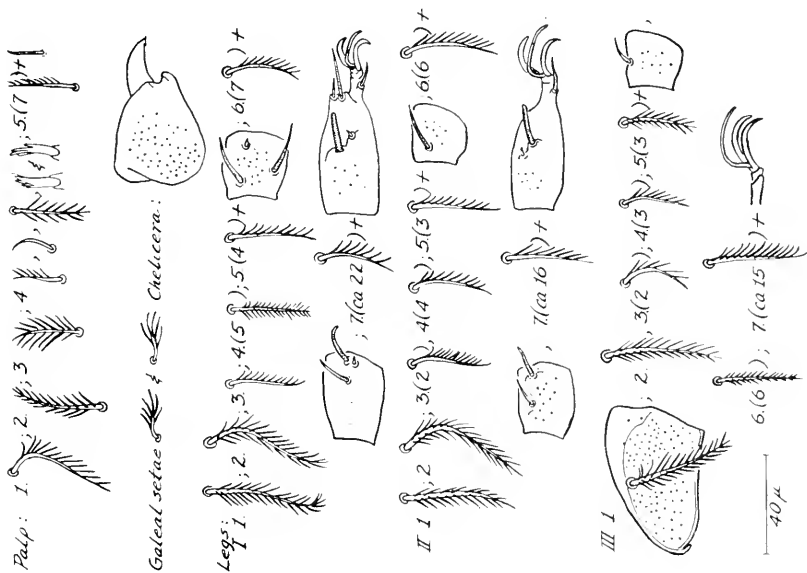
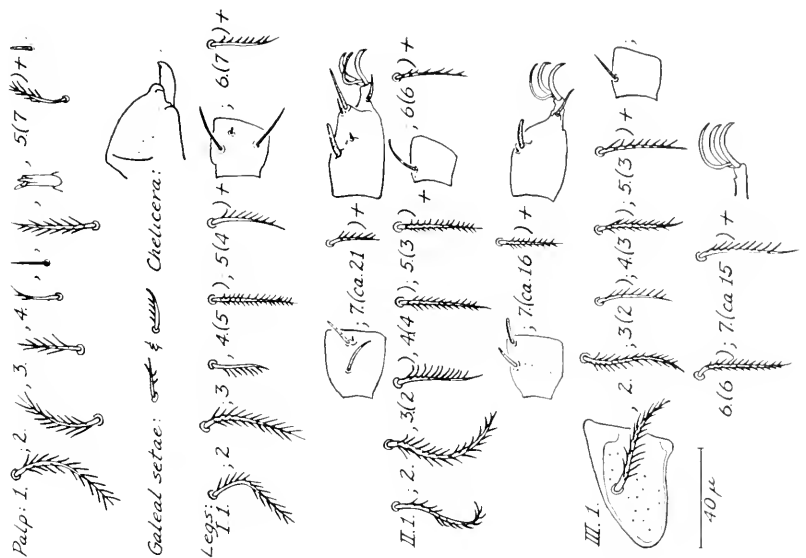
*Euschlingastia guntheri* and *E. criniticollis*. Explanation on page 234.





*Eusebiogastia hamiltoni* and *E. luteodoma*. Explanation on page 234.

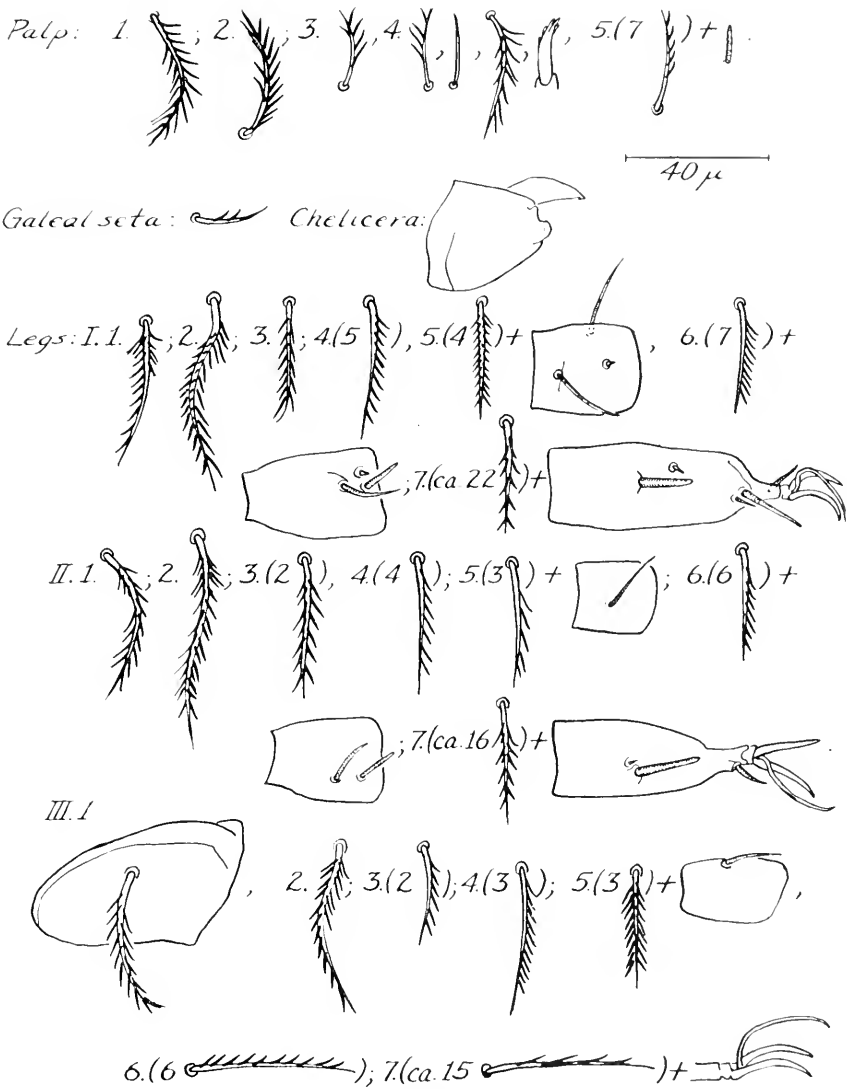




*Euschöngastia crateris* and *E. carolinensis*. Explanation on page 234.







*Euschöngastia sciuricola*. Explanation on page 235.









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## SOME CRICKETS FROM SOUTH AMERICA (GRYLLOIDEA AND TRIDACTYLOIDEA)<sup>2</sup>

By LUCIEN CHOPARD<sup>1</sup>

Through the kindness of Dr. Ashley B. Gurney, I have been able to examine an important collection of Grylloidea and Tridactyloidea<sup>2</sup> belonging to the U. S. National Museum.

Three main lots of specimens comprise the collection:

1. Material collected in northwestern Bolivia by Dr. William M. Mann in 1921-1922 while a member of the Mulford Biological Exploration of the Amazon Basin. A list of his headquarters stations and a map of his itinerary are shown by Snyder (1926) and a popular account of the expedition is given by MacCreagh (1926).

2. Material taken at Pucallpa on the Río Ucayali and at other Peruvian localities by José M. Schunke in 1948-1949 and obtained for the U. S. National Museum by Dr. Gurney.

3. Material collected in 1949-1950 at Tingo María, Perú, and nearby localities by Dr. Harry A. Allard, a retired botanist of the U. S. Department of Agriculture who was engaged primarily in collecting plants.

All of the principal collecting sites represented by this material are in the drainage of the Amazon River. Some 500 miles separate the area worked over by Allard and Schunke from that where Mann collected.

A few Brazilian and Chilean specimens are also included.

The following localities are represented:

BOLIVIA: Blanca Flor; Cachuela Esperanza; Cañamina; Cavinás; Coroico; Covendo; Espia; Huachi; Ivón; Ixiamas; Lower Madidi

<sup>1</sup>Of the Muséum National d'Histoire Naturelle, Paris (MNHN).

<sup>2</sup>For classification of the Orthoptera see Chopard (1949).

River; Mapiri River; Reyes; Rosario, Lake Rogagua; Rurrenabaque; Tumupasa.

BRAZIL: Fortaleza; Manáos; Natal.

CHILE: Cerrillos de Tamaya; Puerto Oscuro.

PERÚ: Cerro Azul; Chanchamayo, Department of Junín; Divisoria; Fundo Chela; Fundo Sinchono; Huancayo; "La Merced," Chanchamayo; Pucallpa; Tingo María.

The grylloids from Perú were known by the study made by Caudell (1918) while most of the Bolivian species have been recorded by Bruner (1916) in his paper on South American crickets.

[Since this manuscript was prepared, and after considerable delay in publication, I have contributed another paper on Peruvian crickets (Chopard, 1954) that was based on material collected by the Hamburg South Perú Expedition of 1936. The general features of that material were discussed by Titschack (1951).]

The present collection provides valuable detailed data on the distribution of the grylloids in Bolivia and Perú, from which countries three-fourths of the material has come. The study of the collection does not bring important changes in our knowledge except in the addition of a relatively considerable number of new species. These new species belong especially to the family Trigonidiidae and to the genera *Diatrypa* and *Aphonomorphus* of the Podoscirtinae. The presence of species belonging to the genera *Rhcnogryllus* and *Metioche*, which were not known in South America, is noteworthy. It confirms the fact that those small crickets, living in very damp places, have a very wide geographical distribution.

I have tried to give keys to the American genera of Grylloidea. I trust they will prove of use to American entomologists in spite of unavoidable imperfections.

## Superfamily GRYLLOIDEA

### Family GRYLLOTALPIDAE

#### Key to the American genera

1. Anterior tibiae with two dactyls; anterior trochanter bearing a long process . . . . . **Scapteriscus** Scudder
- Anterior tibiae with four dactyls; anterior femora bearing a short process . . . 2
2. Very small and slender species; anterior tibiae with open tympanum. **Gryllotalpella** Rehn
- Larger and much stouter species; anterior tibiae with more or less closed tympanum . . . . . 3
3. Posterior tibiae unarmed or armed with one spine only; branches of the *Sc* in the lateral field of elytra very short and perpendicular to the elytral margin . . . . . **Neocurtilla** Kirby
- Posterior tibiae armed with several spines on the superointernal margin; branches of the *Sc* long, oblique . . . . . **Gryllotalpa** Latreille

**Genus *Scapteriscus* Scudder, 1868*****Scapteriscus oxydactylus* (Perty)**

*Gryllotalpa oxydactyla* Perty, *Delictus animalium articulorum*, p. 118, pl. 23, fig. 9, 1832.

SPECIMENS EXAMINED: BOLIVIA: Huachi (1 nymph), Mann; Ivón, February 1922 (1♂), Mann. BRAZIL: Natal, July 1943 (1♀), MacCreary. PERÚ: Tingo María, December 1949 (1♀), Allard.

***Scapteriscus camerani* Giglio-Tos**

*Scapteriscus camerani* Giglio-Tos, *Boll. Mus. Zool. Anat. Comp. Univ., Torino*, vol. 9, p. 45, 1894.

SPECIMENS EXAMINED: BRAZIL: Manáos (1♀), Merrill. PERÚ: Pucallpa, Feb. 15, 1948 (1♀), Schunke; Tingo María, November 1949 (1♂, 2♀♀), December 1949 (2♂♂, 5♀♀, 1 nymph); January 1950 (2♀♀), Allard.

***Scapteriscus borellii* Giglio-Tos**

*Scapteriscus borellii* Giglio-Tos, *Boll. Mus. Zool. Anat. Comp. Univ. Torino*, vol. 9, p. 45, 1894.

SPECIMENS EXAMINED: BOLIVIA: Rurrenabaque, November (1♀), Mann. BRAZIL: Natal, June 25, 1943 (1♀). PERÚ: Tingo María, December 1949 (3♂♂, 1♀), Allard.

**Genus *Neocurtilla* Kirby, 1906*****Neocurtilla hexadactyla* (Perty)**

*Gryllotalpa hexadactyla* Perty, *Delictus animalium articulorum*, p. 119, pl. 23, fig. 9, 1832.

SPECIMENS EXAMINED: BOLIVIA: Rurrenabaque, December (1♀), Mann. PERÚ: Fundo Sinchono, Sept. 6, 1947 (1♀), Schunke; Tingo María, December 1949 (1♀), Allard.

**Family GRYLLIDAE****Key to the American genera**

1. Posterior tibiae armed with strong, immovable, glabrous or feebly pubescent spines (*Gryllinae*) . . . . . 2
- Posterior tibiae armed with long, movable, pubescent spines (*Nemobinae*) . . . . . 10
2. Posterior femora as long as tarsus and tibia united; body glabrous, shining . . . . . 3
- Posterior femora shorter than the tibia and tarsus united; body usually covered with a fine pubescence . . . . . 4
3. Posterior tibiae presenting a few denticles before the spines of the external margin; male elytron with five oblique veins; ovipositor short but normally conformed . . . . . **Megalogyllus** Chopard

- Posterior tibiae without denticles at base of the external margin; male elytron with two oblique veins; ovipositor rudimentary . . . **Anurogryllus** Saussure
4. Posterior tibiae serrulated before the spines . . . **Odontogryllus** Saussure  
Posterior tibiae without denticles before the spines . . . . . 5
5. Both sexes completely apterous . . . . . **Cophogryllus** Saussure  
Elytra perfectly developed, at least in the male sex . . . . . 6
6. Elytra of the male truncated at apex, without apical field; those of the female strongly reduced or absent . . . . . 7  
Elytra of the male with more or less developed apical field; those of the female never reduced to lateral lobes . . . . . 8
7. Body depressed, pubescent; frontal rostrum narrow . . . **Gryllodes** Saussure  
Body more convex, shining with a scarce pubescence; frontal rostrum wide. **Gryllita** Hebard
8. Posterior metatarsi strongly enlarged, furrowed above, with serrulated external margin; general shape short and stout; anterior tibiae with a large internal tympanum . . . . . **Hemigryllus** Saussure  
Posterior metatarsi not at all enlarged, serrulated on both margins; anterior tibiae with a large external tympanum; when the internal tympanum is present, it is small, round . . . . . 9
9. Small species, with short elytra combined with very long wings (micropterous condition is present); facies of a *Nemobius* . . . . **Miogryllus** Saussure  
Average size of the species larger; elytra and wings not so different in length. **Acheta** Linné
10. Posterior tibiae armed with two apical spurs only on the internal face. **Hygronemobius** Hebard  
Posterior tibiae armed with three apical spurs either side . . . . . 11
11. Pronotum twice as wide as long . . . . . **Argizala** Walker  
Pronotum about  $1\frac{1}{2}$  times as wide as long. **Pteronemobius** Jacobson and Bianchi

### Genus *Megalogryllus* Chopard, 1929

#### *Megalogryllus molinai* Chopard

*Megalogryllus molinai* Chopard, Rev. Chilena Hist. Nat., vol. 33, p. 523, fig. 2, 1929.

SPECIMENS EXAMINED: BOLIVIA: Blanca Flor, July–August 1921 (1 ♂, 2 ♀♀), January 1922 (2 ♂♂, 1 ♀), Mann. PERÚ: Pucallpa, Jan. 11, 1948 (1 ♂, 2 ♀♀), Schunke.

REMARKS: This species was previously known from Brazil and British Guiana.

### Genus *Anurogryllus* Saussure, 1877

#### *Anurogryllus muticus* (De Geer)

*Gryllus muticus* De Geer, Mémoires pour servir à l'histoire des insectes, vol. 3, p. 520, pl. 43, fig. 2, 1773.

SPECIMENS EXAMINED: BOLIVIA: Cañamina, July 1921 (1 ♂), Mann; Espia (1 ♂), Mann; Ivón (1 ♀), Mann; Rosario, Oct. 28–Nov. 9, 1921 (1 ♀), Mann; Rurrenabaque, October 1921 (1 ♀), Mann. PERÚ: Chanchamayo, June 3, 1948 (1 ♂), May 6, 1948 (1 ♀), Schunke; La Merced, Jan. 31, 1949 (1 ♂), Schunke; Pucallpa, Mar. 2, 1948



(1♀), Mar. 15, 1948 (1♂), Apr. 11, 1948 (1♀), Schunke; Tingo María, November 1949 (1♂, 1♀), December 1949 (7♂♂, 1♀), January 1950 (2♂♂, 1♀, 1 nymph), Allard.

REMARKS: The length of the organs of flight is very variable in this species. Nine of the females are perfectly macropterous, whereas one has no wings and very short elytra. None of the males shows the macropterous condition.

### Genus *Acheta* Linné, 1758

#### *Acheta assimilis* (Fabricius)

*Gryllus assimilis* Fabricius, *Systema entomologiae*, p. 280, 1775.

SPECIMENS EXAMINED: BOLIVIA: Cañamina (1♂, 1♀). BRAZIL: Fortaleza, September 1943 (1♀), MacCreary. CHILE: Puerto Oscuro, Sept. 26, 1947 (1♂), Guzman; Cerrillos de Tamaya, Sept. 16, 1947 (1♀), Guzman. PERÚ: Chanchamayo, June 21, 1948 (1♂, 1♀), Schunke; Pucallpa, Sept. 10, 1947 (3♂♂, 2♀♀), Schunke; Tingo María, December 1949 (1♀), Allard.

#### *Acheta peruviansis* (Saussure)

*Gryllus peruviansis* Saussure, *Mission scientifique au Mexique . . . Recherches zoologiques*, pt. 6, section 1 (Orthoptères), p. 406, 1874.

SPECIMENS EXAMINED: PERÚ: Huancayo, Mar. 4–11, 1943 (2♀♀), Jacoslav Soukup.

#### *Acheta fulvastra*, new species

FIGURE 3,a

TYPES: Holotype: Male, Lower Madidi River, Bolivia, January 1921, Mann (USNM 62061). Allotype: Rosario, Lake Rogagua, Bolivia, Oct. 28–Nov. 9, 1921, Mann (♀) (USNM). Paratypes: Covendo, Bolivia (1♂), Mann; Rosario, Lake Rogagua, Bolivia, Oct. 28–Nov. 9, 1921, Mann (1♂, 1♀); Rurrenabaque, Bolivia, Mann (1♂); Pucallpa, Río Ucayali, Perú, Mar. 6, 1948, Schunke (1♂) (USNM; MNHN).

DESCRIPTION: Medium size; coloration rather uniformly rufo-testaceous. Head as wide as pronotum, entirely of a light rufous brown; frontal rostrum sloping, as wide as 1st antennal joint. Face scarcely longer than wide; clypeofrontal suture almost straight. Antennae rufous. Palpi light yellow; 4th joint shorter than 3d, 5th large, feebly enlarged at apex, with slightly concave superior margin, apex somewhat obliquely truncated.

Pronotum with parallel margins, anterior margin very feebly concave,  $1\frac{1}{2}$  times as wide as long; disk rather strongly convex, covered with a very fine pubescence; lateral lobes a little darker than the disk, with straight inferior margin. Abdomen light yellowish brown, pubescent; epiproct relatively very long. Genitalia very long and narrow (fig. 3,a).

Legs yellowish, pubescent. Anterior tibiae a little compressed, enlarged at apex, presenting a large, oval, external typanum and a very small, round internal one; apex armed with three rather strong apical spurs which are very close together; metatarsi compressed, as long as the other two joints united. Medium tibiae armed with four apical spurs. Posterior femora rather short and thick; tibiae a little shorter than the femora, armed with long and strong spines, six on the external, five on the internal margin; the two large apical spurs equal in length; metatarsi with seven to eight denticles on each superior margin.

**MALE:** Elytra smoky, extending to the apex of the 5th abdominal tergite; mirror feebly wider than long, much rounded backwards, with almost right anterior angle, dividing vein in the middle, curved (this vein is variable in the different specimens of the species); two oblique veins; anal field short, with three veins and regular, long areolae; lateral field high, pellucid in the inferior part, with five regularly spaced veins and the *Sc* bearing one branch. Wings very short.

**FEMALE** (macropterous form): Elytra longer than those of the male, rounded at apex; dorsal field with very regular, feebly oblique veins; *Cu* bearing three branches, followed by five veins; lateral field as in the male; *Sc* plain or furcate at apex. Wings decidedly caudate. Ovipositor straight, with apical valves perfectly limited by a stranguation of the stem, lanceolate with straight margins, flat above.

**DIMENSIONS** (in millimeters): Length of body, ♂ 14.0, ♀ 15.0, pronotum, ♂ 2.9, ♀ 3.0; posterior femur, ♂ 9.5, ♀ 10.0; elytra, ♂ 6.5, ♀ 8.2; ovipositor, 8.5; wings of female extending beyond elytra by 11 mm.

### Genus *Miogryllus* Saussure, 1877

#### *Miogryllus convolutus* (Johansson)

*Gryllus convolutus* Johansson, in Linné, *Amoenitates academicae*, vol. 6, p. 399, 1763.

**SPECIMENS EXAMINED:** BOLIVIA: Blanca Flor, January 1922 (1 ♂), Mann. PERÚ: Pucallpa, Sept. 16, 1947 (2♀♀), Oct. 8, 1947 (4♀♀), Oct. 13, 1947 (1♀), Jan. 10, 1948 (1♀), Mar. 3, 1948 (1 ♂, 1♀), Schunke; Tingo María, November 1949 (1♀), December 1949 (1 ♂, 1♀), January 1950 (1♀), Feb. 24, 1950 (1 nymph), Feb. 26, 1950 (1 ♂), Allard.

**REMARKS:** The specimens from Tingo María and one male from Pucallpa are micropterous; the remainder are macropterous.

#### *Miogryllus verticalis* (Serville)

*Gryllus verticalis* Serville, *Histoire naturelle des insectes orthoptères*, p. 343, 1839.

**SPECIMENS EXAMINED:** PERÚ: Chanchamayo, May 29, 1948 (1 ♂), Schunke.

***Miogryllus brevipennis* Saussure**

*Grylloides brevipennis* Saussure, Mission scientifique au Mexique . . . Recherches zoologiques, pt. 6, section 1 (Orthoptères), p. 418, 1874.

SPECIMENS EXAMINED: BOLIVIA: Rurrenabaque, October 1921 (1♀), Mann.

**Genus *Hemigryllus* Saussure, 1877*****Hemigryllus ortonii* (Scudder)**

*Nemobius ortonii* Scudder, Proc. Boston Soc. Nat. Hist., vol. 12, p. 330, 1869.

SPECIMENS EXAMINED: BOLIVIA: Blanca Flor, January 1922 (3♂♂); Espia (1♂, 1♀); Mapiri, September 1921 (6♂♂); Rurrenabaque, December 1921 (2♂♂, 3♀♀), all collected by Mann.

**Genus *Argizala* Walker, 1869*****Argizala brasiliensis* Walker**

*Argizala brasiliensis* Walker, Catalogue of the . . . Dermaptera Saltatoria . . . in the British Museum, vol. 1, p. 61, 1869.

SPECIMENS EXAMINED: BOLIVIA: Ivón, February 1922 (1♂); Rosario, Oct. 18–Nov. 9, 1921 (1♂), Mann. PERÚ: Pucallpa, Jan. 10, 1948 (2♂♂, 1♀), Mar. 3, 1948 (2♂♂, 1♀), Mar. 9, 1948 (1♂), Schunke.

***Argizala hebardi* (Rehn)**

*Nemobius (Argizala) hebardi* Rehn, Proc. Acad. Nat. Sci. Philadelphia, vol. 67, p. 290, 1915.

*Nemobius argentinus* Bruner, Ann. Carnegie Mus., vol. 10, p. 371, 1916.

SPECIMENS EXAMINED: BOLIVIA: Rosario, Oct. 28–Nov. 9 1921, (25♂♂, 21♀♀), Mann.

**Genus *Pteronemobius* Jacobson and Bianchi, 1904**

The genus *Pteronemobius* differs from *Nemobius* Serville in the number of spines of the posterior tibiae, which in *Nemobius* is always three on each margin in both sexes; the first internal spine is never specialized in the male as it is in *Pteronemobius*. The macropterous condition is not known in the species of *Nemobius* and no species of the genus has yet been found in America.

***Pteronemobius cubensis* (Saussure)**

FIGURE 3,c

*Nemobius cubensis* Saussure, Mission scientifique au Mexique . . . Recherches zoologiques, pt. 6, section 1 (Orthoptères), p. 384, pl. 7, fig. 5, 1874.

SPECIMENS EXAMINED: BOLIVIA: Rosario, Oct. 28–Nov. 9, 1921 (6♂♂, 3♀♀), Mann.

*Pteronemobius longipennis* Saussure

*Nemobius longipennis* Saussure, Mission scientifique au Mexique . . . Recherches zoologiques, pt. 6, section 1 (Orthoptères), p. 383, 1874.

*Nemobius argentinus* Chopard, Ann. Soc. Ent. France, p. 559, figs. 87-89, 1918 (not *argentinus* Bruner 1916).

SPECIMENS EXAMINED: BOLIVIA: Rosario, Oct. 28-Nov. 9, 1921 (6 ♂♂, 7 ♀), Mann; Rurrenabaque, November 1921 (1 ♀), Mann (micropterous). PERÚ: Pucallpa, Oct. 8, 1947 (2 ♂♂), Jan. 10, 1948 (3 ♂♂), Mar. 2, 1948 (1 ♀), Schunke (macropterous).

REMARKS: According to Saussure's description, this species should have the last joint of maxillary palpi not longer than the preceding; I have never seen an American nemobiid presenting exactly this character, but the maxillary palpi are somewhat shorter in the present species than in the neighboring forms.

*Pteronemobius schunkei*, new species

HOLOTYPE: Male; Divisoria, elevation 1,600 meters, about 80 miles southwest of Pucallpa, Río Ucayali, Perú, November 1947, Schunke (USNM 62062).

MALE: Rather small and short. Head short, rounded, a little wider than the pronotum; vertex weakly sloping; coloration rufous brown above, rather strongly darkened towards the apex of the rostrum; frontal rostrum a little wider than 1st antennal joint, rounded. Face as long as wide, very dark brown. Eyes rounded, projecting; ocelli very small, the anterior one a little before the extremity of the rostrum. Antennae and palpi brown; 4th joint of maxillary palpi very short, 5th almost four times as long, rather feebly enlarged at top.

Pronotum transverse, very feebly narrowing in front, with straight anterior and posterior margins; disk feebly convex, brownish with a lateral light band; lateral lobes blackish brown, with straight inferior margin. Abdomen dark brown.

Legs rather short, pubescent, rufous with a few brown spots; anterior and medium tarsi almost as long as the tibiae. Posterior femora short and thick, striated with brown on the external face; tibiae armed on each margin with four slender spines feebly curved at apex; internal spines much longer than the external, chiefly the 4th which is longer than the larger spur; 1st spine very small, feebly tuberculiform; inferior spurs feebly unequal in length; metatarsi very long.

Elytra brown, shining, extending almost to the apex of abdomen; mirror very small, almost apical, obliquely transverse, with right anterior angle; apical part divided into two cells, one large and one very small; diagonal vein long, feebly curved at base, straight after;

chord straight; lateral field almost black with four parallel veins. No wings.

Length of body 7.0 mm.; posterior femur 5.0 mm.; elytra 4.0 mm.; pronotum 1.5 mm., width of pronotum 2.4 mm.

REMARKS: This species has the same size and general habitus as *P. cubensis* but the elytral mirror and genitalia are strongly different (fig. 3,b,c).

### **Genus *Hygronemobius* Hebard, 1915**

#### ***Hygronemobius albipalpus* (Saussure)**

*Nemobius albipalpus* Saussure, Mém. Soc. Phys. Hist. Nat. Genève, vol. 25, p. 89, 1877.

SPECIMENS EXAMINED: PERÚ: Pucallpa, Oct. 8, 1947 (1♂, 5♀♀), Oct. 13, 1947 (1♀), Jan. 10, 1948 (1♀), Mar. 2, 1948 (1♀), Schunke.

#### ***Hygronemobius longespinosus*, new species**

FIGURE 1,a

HOLOTYPE: Female: Rurrenabague, Río Beni, Bolivia, November 1921, Mann (USNM 62063).

FEMALE: Small; testaceous, a little mottled with brown. Head rounded, presenting above two very feeble brown bands; four rows of long bristles extending to the apex of the vertex. Face yellowish with two rounded brown spots near the internal margin of the antennal sockets. Antennae and palpi yellowish; 5th joint of maxillary palpi in the shape of a long triangle, feebly enlarged at apex.

Pronotum feebly narrowing in front, with posterior margin convex; disk yellowish varied with large brown spots, bearing long bristles; lateral lobes with weakly sinuated inferior margin, rounded angles; their color is dark brown with a few small yellow spots, inferior margin lined with yellowish. Abdomen varied with yellowish and brownish. Ovipositor rather short, very weakly curved, with apical valves occupying more than half the total length, very acute at apex, their margins smooth, the inferior ones very narrow.

Anterior legs wanting. Median femora yellowish with two small transverse bands, apex also brownish; tibiae with two brownish rings; metatarsi as long as the two other joints united. Posterior femora yellowish with oblique brown stripes on the external face, superior margin entirely brownish, small rings of the same color a little before the apex; internal face presenting in superior part only three brownish bands; tibiae adorned with two light brown rings near the base and small spots at base of each spine; these are very long, pubescent, brown with yellow base and apex, and there are three on each margin;

externomedian apical spur equaling half the length of the metatarsus; superointernal apical spur extending to the apex of the metatarsus.

The right elytron is wanting; left elytron presenting only three straight, equidistant veins, without transverse veinlets. Wings very long.

Length of body 5.0 mm.; length with wings 10.5 mm.; posterior femur 4.2 mm.; ovipositor 2.4 mm.; elytra 2.6 mm.

REMARKS: This species is very close to the preceding; it is of a more uniform coloration, with concolorous last joint of maxillary palpi, which is also longer and less strongly enlarged at apex; spines and spurs of the posterior tibiae much longer.

## Family MOGOPLISTIDAE

### Key to the American genera

1. Posterior metatarsus very long, almost unarmed above. **Cycloptiloides** Sjöstedt

Posterior metatarsus armed with spinules on the superior margins . . . . . 2
2. Anterior tibiae without tympana . . . . . 3
 

Anterior tibiae provided with an auditory tympanum on the internal face . . . 4
3. Apical spurs of the posterior tibiae very long . . . . . **Microgryllus** Philippi
 

Apical spurs of the posterior tibiae short. **Oligacanthopus** Rehn and Hebard
4. Elytra of the male completely hidden under the pronotum. **Ectatoderus** Guérin

Elytra of the male partly visible . . . . . 5
5. Pronotum of male elongate, rounded behind; elytra with periphery only visible beyond pronotum . . . . . **Cycloptilum** Scudder
 

Pronotum of male almost truncated behind; tegmina almost completely visible . . . . . **Ornebius** Guérin

## Family PENTACENTRIDAE

### Key to the American genera

1. Posterior metatarsi very long, cylindrical, unarmed above . . . . . 2
 

Posterior metatarsi compressed, denticulated above . . . . . 3
2. Eyes well developed; ocelli present; anterior tibiae perforated; elytral venation normal . . . . . **Trigonidomimus** Caudell
 

Eyes degenerated; no ocelli; anterior tibiae without tympana; elytra corneous, without distinguishable mirror . . . . . **Tohila** Hubbell
3. Elytra of the male feebly differentiated, showing the anal vein and one oblique vein; posterior tibiae with four or five spines on each margin, six apical spurs; posterior metatarsi twice as long as the other joints united. **Aphemogryllus** Rehn

Elytra similar in both sexes, with longitudinal, parallel veins; posterior femora short without filiform apical part; posterior tibiae armed with three spines on each margin and five apical spurs; metatarsi not so long, dilated in the male . . . . . **Nemobiopsis** Bolívar

**Genus *Trigonidomimus* Caudell, 1912*****Trigonidomimus ruficeps*, new species**

**TYPES:** Holotype, female; Covendo, Bolivia, August 1921, Mann (USNM 62064). Allotype: Pucallpa, Río Ucuyali, Perú, Nov. 2, 1947, Schunke (♂) (USNM). Paratype: Pucallpa, Río Ucuyali, Perú, Mar. 15, 1948, Schunke (♀) (USNM).

**FEMALE:** Size a little larger than the other species of the genus. Head entirely reddish, smooth; vertex sloping, ending between the antennae in a very short and narrow rostrum. Face rufous yellow, smooth. Eyes large, dorsoventrally lengthened; ocelli scarcely visible. Labial palpi brown; maxillary palpi wanting. Antennae (a short part remains) brown with very large, flattened first joint.

Pronotum very dark brown, shining, almost glabrous; with straight anterior and posterior margins, both bordered with long bristles; disk feebly convex with a faint median furrow; lateral lobes concolorous, their inferior margin straight, anterior angle right, feebly rounded. Abdomen blackish brown. Cerci yellowish. Ovipositor rather short, very feebly curved upwards; apical valves extremely narrow and acute.

Legs long and slender. Anterior femora yellowish at base and above, with internal face brown, external face brown at apex, the brown spot narrowing towards the base; tibiae brown with a rather small, nearly round tympanum at base of the internal face; apex armed with two small and slender spurs; tarsus almost as long as the tibia, the metatarsus longer than the other two joints united. Median legs similar to the anterior ones. Posterior femora moderately swollen at base, without filiform apical part, adorned externally with three longitudinal brown bands, uniting after the middle; tibiae brown, armed with three spines on each margin and six slender apical spurs; medio-external spur a little longer than the superior one, which is very thin; superointernal spur much longer than the median. Metatarsi very long.

Elytra extending almost to the apex of abdomen, dark brown; dorsal field with five feebly oblique, parallel veins, the two internal ones uniting towards the middle; lateral field high, blackish brown, with three distant, feebly incurved at base veins. Wings no longer than the elytra.

**MALE** (allotype): General aspect and color of the female. Head as in the female; palpi blackish; 5th joint of the maxillary palpi very large, feebly widening at apex, with slightly concave superior margin, apex lengthily truncated, feebly rounded, internal margin very short. Legs as in the female but somewhat more blackish. Elytra blackish, extending only to the apex of the 6th abdominal tergite; mirror large,

narrow, almost twice as long as wide, with very acute anterior margin, rounded backwards, divided beneath the middle by an oblique, somewhat curved vein; diagonal vein as long as the internal margin of the mirror; chords much longer, feebly curved, very close one to the other; apical field very short; *Sc* bearing two branches. Wings exceeding very much the elytra, whitish.

**DIMENSIONS** (in millimeters): Length of body, ♀ 9.0, ♂ 7.5; length with wings, ♂ 13; pronotum, 2.0; posterior femur, ♀ 7.0, ♂ 5.0; elytra, ♀ 6.0, ♂ 2.0; ovipositor, 5.5.

*Trigonidomimus zernyi* (Chopard)

*Quarequa zernyi* Chopard, Ann. Naturh. Mus. Wien, vol. 46, p. 246, fig. 9, 1933.

**SPECIMENS EXAMINED:** PERÚ: Tingo María, November 1949 (1♀), Allard.

**Family PHALANGOPSIDAE**

**Key to the American genera**

1. Pronotum wider than long, with lateral lobes square or rounded, not attenuated in front . . . . . 2  
     Pronotum long, with lateral lobes narrowing in front, their inferior margin ascending forwards . . . . . **Cophus** Saussure
2. Frontal rostrum between the antennae wide; inferior margin of the lateral lobes of pronotum straight; last joint of maxillary palpi obliquely truncated at apex; legs short (*Luzarae* group) . . . . . 3  
     Frontal rostrum between the antennae narrow; inferior margin of the lateral lobes of pronotum ascending backwards . . . . . 21
3. Elytra well developed, their structure delicate; venation conspicuous, dorsal field of male deplanate . . . . . 4  
     Elytra moderately to greatly reduced or absent; when present, with structure chitinous, often corneous; venation of dorsal field weak or obsolete . . . 7
4. Lateral field of male tegmina specialized; *Sc* with numerous branches . . . 5  
     Lateral field of male tegmina with simple venation; *Sc* without oblique branches . . . . . **Prosthacusta** Saussure
5. Anterior tibiae with foramina on both faces; male tegmina ample, widening behind . . . . . 6  
     Anterior tibiae with foramen on internal face only; male tegmina not widening caudad . . . . . **Lernecella** Hebard
6. Superointernal apical spur of posterior tibiae longer than the median; tibiae armed with four spines on each margin; mirror of male elytra triangular; apical field provided with longitudinal veins . . . . . **Lerneca** Walker  
     Superointernal apical spur of posterior tibiae shorter than the median; tibiae armed with three spines on the external margin, one on the internal, with very strong denticles before the spines; mirror of male elytra almost oval; apical field with transverse veins . . . . . **Benoistiella** Uvarov
7. Anterior tibiae with auditory foramina on one or both faces . . . . . 8  
     Anterior tibiae without auditory foramina . . . . . 18
8. Tegmina with lateral field having two unbranched longitudinal veins . . . 9  
     Tegmina with lateral field having more than two longitudinal veins (some of which branch in the males) . . . . . 12



9. Anterior tibiae with auditory foramen on internal face only . . . . . 10  
Anterior tibiae with foramina on both faces . . . . . *Tairona* Hebard
10. Male tegmina overlapping in such a way that the dextral dorsal field almost wholly covers the sinistral; venation there obsolete but a distinct depression showing the archet; entire dorsal surface strongly hirsute, elytra not at all glabrous . . . . . *Gryllosoma* Hebard  
Male tegmina with dextral dorsal field covering only slightly more than half the sinistral; dorsal exposed field with venation obsolete, smooth, convex, without lateral angle; dorsal surface more or less polished, weakly or not at all hirsute . . . . . 11
11. Form more robust; palpi elongate. Female tegmina slightly overlapping . . . . . *Rehniella* Hebard  
Form less robust; size small; palpi very elongate. Female tegmina represented by small lateral pads . . . . . *Prosthama* Hebard
12. Anterior tibiae with auditory foramen on internal face only . . . . . 13  
Anterior tibiae with auditory foramina on both faces . . . . . 15
13. Palpi simple. Male tegmina with entire shining dorsal surface weakly convex . . . . . 14  
Palpi with 4th and 5th joints expanded and flattened. Male tegmina entire dorsal surface flat . . . . . *Palpiger* Hebard
14. Palpi moderately elongate. Male tegmina without trace of venation. *Niquirina* Hebard  
Palpi elongate. Male tegmina with impressed archet and mere traces of other venation . . . . . *Amusina* Hebard
15. Impressions of pronotal disk feeble, inconspicuous. Antennae annulate . 16  
Impressions of pronotal disk distinct. Antennae and limbs not annulate. Size very large . . . . . *Megalamus* Hebard
16. Form more robust with shorter limbs . . . . . 17  
Form slender with very elongate limbs for the group . . . . . *Amusodes* Hebard
17. Tegmina with venation reduced, delicate but distinct . . . . . *Luzarida* Hebard  
Tegmina with venation greatly reduced, almost obliterated . . . . . *Luzara* Walker
18. Eyes not strongly projecting; palpi not annulate; limbs short . . . . . 19  
Eyes more strongly projecting; palpi annulate; limbs of medium length. *Anacusta* Hebard
19. Lateral lobes of pronotum diverging backwards so that the posterior angle is distinctly visible from above. Both sexes with short elytra . . . . 20  
Lateral lobes of pronotum nearly perpendicular. Female apterous. *Miogryllodes* Hebard
20. Limbs very short. Projection formed by fastigium and face moderately developed. Dorsal surface of body moderately hirsute . . . . . *Cophella* Hebard  
Limbs short. Projection weak and very broadly rounded. Dorsal surface of body shining, hairs exceedingly minute . . . . . *Paracophella* Hebard
21. Last joint of maxillary palpi truncated at apex only. Legs relatively short (*Heterogrylli* group) . . . . . 22  
Last joint of maxillary palpi strongly and obliquely truncated at apex (*Amphiacustae* group) . . . . . 32
22. Frontal rostrum as wide as first antennal joint . . . . . 23  
Frontal rostrum very narrow . . . . . 24
23. Maxillary palpi short; very small for the group (10 mm.). *Eugryllina* Hebard  
Maxillary palpi long; size larger (15-16 mm.) . . . . . *Dyscophogryllus* Rehn
24. Anterior tibiae nonperforated or with scarcely visible auditory tympana . 25  
Anterior tibiae with auditory tympana on one or both faces . . . . . 28

25. Both sexes completely apterous . . . . . **Arachnopsis** Saussure  
Males with greatly reduced elytra, without perceptible veins; female apterous . . . . . 26
26. Legs and palpi short . . . . . **Laranda** Walker  
Legs and palpi very long, posterior femora with filiform apical part . . . . . 27
27. Legs moderately elongate; elytra of male triangular, thick, feebly distant on the median line . . . . . **Eidmanacris**, new name<sup>3</sup>  
Legs extremely long; elytra of male thin, overlapping, truncated at apex.  
**Phalangopsis** Serville
28. Anterior tibiae perforated on both faces . . . . . **Paragryllus** Guérin  
Anterior tibiae perforated on one face only . . . . . 29
29. Anterior tibiae perforated on the internal face . . . . . 30  
Anterior tibiae perforated on the external face . . . . . **Ectecous** Saussure
30. Elytra of male short, triangular, without well defined mirror; those of the female reduced to lobiform, lateral pads . . . . . **Uvaroviella** Chopard  
Elytra of the male with well defined mirror . . . . . 31
31. Mirror oval, divided by numerous veins; female apterous . . . . . **Acla** Hebard<sup>4</sup>  
Mirror vaguely triangular, divided near the apex by one or two irregular veins; elytra present in the female . . . . . **Aclodes** Hebard
32. Elytra of male very short, truncated, or absent . . . . . **Paracophus** Chopard  
Elytra of male moderately short with normal venation . . . . . 33
33. Superior apical spur of posterior tibiae longer than the median on both sides; anterior tibiae perforated on the internal face . . . . . **Endecous** Saussure  
Superior apical spur of posterior tibiae shorter than the median . . . . . 34
34. Anterior tibiae perforated on both faces; elytra of male rather short, rounded; mirror with two dividing veins . . . . . **Amphiacusta** Saussure  
Anterior tibiae perforated on the external face only; elytra of male coriaceous; mirror divided by several veins . . . . . **Hemicophus** Saussure

### Genus *Prosthacusta* Saussure, 1874

#### *Prosthacusta amplipennis*, new species

FIGURES 1,c, 3,d

**HOLOTYPE:** Male; Pucallpa, Río Ucuyali, Perú, Sept. 16, 1947, Schunke (USNM 62065).

**MALE:** Close to *P. circumcincta* Saussure; coloration rather uniform light brown. Head rather small, as wide as pronotum, uniformly brownish, almost glabrous; vertex strongly sloping; frontal rostrum as wide as first antennal joint. Face long, yellowish, smooth. Antennae and palpi yellowish; maxillary palpi rather long, the three last joints equal in length, the last one feebly enlarged, obliquely truncated at apex.

Pronotum as long as wide, with straight anterior and posterior margins; disk strongly convex, brown, smooth, glabrous; lateral lobes long, with inferior margin straight, rounded angles. Abdomen dark brown above, yellowish beneath; subgenital plate long, truncated at apex; epiproct almost twice as wide as long, feebly truncated at apex,

<sup>3</sup> For *Eidmantella* Chopard (Aug. 1938), preoccupied by *Eidmantella* Keler (March 1938).

<sup>4</sup> It seems that this genus may represent the male sex of *Heterogryllus* Saussure; in that case, the last name would have priority.

furrowed at base. Genitalia triangular in their general shape, with four narrow apical processes (fig. 3, *d*).

Anterior and median legs rather long and slender; femora somewhat darkened at apex; tibiae vaguely annulated, the anterior ones presenting a small auditory foramen near the base of the internal face. Posterior femora rather short, strongly dilated at base, without apical filiform part, with darkened apex; before the brown part there is a yellowish ring; internal and inferior faces mottled with brown. Tibiae brown at base, presenting little after the brown part a ring of the same color; base of the spines spotted with brown; superior margins rather strongly serrulated and armed with four spines; superoexternal and inferoexternal apical spurs very short, the median twice as long; inferointernal spur a little longer than the external; superointernal longer than the median, a little more than half the length of the metatarsus; the latter is long, brown at apex, armed above with a few denticles, the apical spurs rather short.

Elytra extending to the apex of abdomen, rather strongly widening caudad, rufous brown, shining, with a rather feeble yellow, opaque, band all round; internal margin feebly convex; internal angle and apical margin strongly rounded; dorsal field somewhat corneous with rather feeble veins; diagonal vein very short, divided, forming a very long, triangular mirror; two chords, the internal of which extending along the apical margin as far as the external angle; six long, parallel, straight oblique veins; anal vein very faint; anal field especially thickened; lateral field rather small, with three plain veins, the third one emerging from base of the *Sc*. No wings.

Length of body 11.5 mm.; pronotum 2.4 mm.; width of pronotum 2.5 mm.; posterior femur 9 mm.; elytra 7.5 mm.

REMARKS: This species differs from *circumcincta* in the more uniform coloration and the wider elytra with quite different venation.

### Genus *Miogryllodes* Hebard, 1928

#### *Miogryllodes* sp.

SPECIMENS EXAMINED: BRAZIL: Near Pará (1♀ nymph), Merrill. Certainly belonging to this genus, but specifically undeterminable.

### Genus *Luzara* Walker, 1869

#### *Luzara rufipennis* Walker

*Luzara rufipennis* Walker, Catalogue of the . . . Dermaptera Saltatoria . . . in the British Museum, vol. 1, p. 103, 1869.

SPECIMENS EXAMINED: BOLIVIA: Tumupasa, December 1921 (1♀), Mann. PERÚ: Chanchamayo, July 22, 1948 (1♂), Schunke; Río Ucuyali, Apr. 30, 1947 (1♂), Schunke.

**Genus *Luzarida* Hebard, 1923*****Luzarida pulla* Hebard**

*Luzarida pulla* Hebard, Trans. Amer. Ent. Soc., vol. 54, p. 41, pl. 8, fig. 1, 1928.

SPECIMENS EXAMINED: BOLIVIA: Tumupasa, December 1921 (1♀), Mann.

**Genus *Paragryllus* Guerin, 1844*****Paragryllus temulentus* Saussure**

*Paragryllus temulentus* Saussure, Mem. Soc. Phys. Hist. Nat. Genève, vol. 25, p. 413, 1878.

SPECIMENS EXAMINED: BOLIVIA: Cachuela Esperanza, March 1922 (1♀), Mann; Tumupasa, December 1921 (1♀), Mann.

**Genus *Acla* Hebard, 1923*****Acla reticulata*, new species****FIGURE 3,*e***

HOLOTYPE: Female; Fundo Sinchono, elevation 1,550 meters, about 40 miles southwest of Pucallpa, Río Ucuyali, Perú, Sept. 2, 1947, Schunke (USNM 62066).

MALE: Size small. Head as wide as pronotum; occiput and vertex short, strongly convex, rufous adorned with four brown bands, finely pubescent; frontal rostrum very narrow, brown. Face long, shining brown with a median yellow band. Eyes strongly projecting forwards; ocelli small, the anterior one at extremity of the rostrum, the lateral ones very distant from it, quite at base. Antennae wanting. Palpi rather long, brownish; 3d and 4th joints of the maxillary palpi equal in length, 5th longer, feebly enlarged, truncated at apex only.

Pronotum transverse, pubescent, with straight anterior and posterior margins, furrowed median line; disk feebly convex, irregular, rufous brown with brown spots; lateral lobes blackish, with inferior margin strongly ascending backwards. Abdomen brown mottled with rufous above, brownish beneath; subgenital plate of medium size, weakly narrowing at apex, with feebly truncated posterior margin. Genitalia wide, the superior part forming a narrow bridge with a median process in the shape of a trident; inferior parts depressed with a long, curved lateral process (fig. 3,*e*).

Legs long, annulated with brown. Anterior tibiae perforated with a small, oval tympanum at base of the internal face; tarsi very long. Posterior femora strongly dilated at base, adorned on the external face with two oblique brown bands and three rings—one in the middle, one in the narrow apical part, and one at apex. Tibiae with three brown rings, armed with four external, three internal spines, finely

serrulated; superoexternal and inferoexternal apical spurs very short, median twice as long; inferointernal spur very small, much shorter than the external, median and superior of the same length, scarcely reaching the middle of the metatarsus, which is very long.

Elytra extending to the apex of the 6th abdominal tergite, dark brown, finely pubescent, with yellowish veins; anal field small; archet with a much-rounded angle; mirror large but somewhat confused, subtriangular, filled with a rather regular reticulation; chords irregular, very distant, the 2d incomplete; five oblique veins, parallel to one another; apical field almost null; lateral field small, blackish, with inferior margin very oblique, presenting three regular veins. No wings.

Length of body 10.0 mm.; pronotum 2.1 mm.; width of pronotum 3.0 mm.; posterior femur 10.5 mm.; elytra 5.0 mm.

REMARKS: This species is quite distinct by the reticulation which almost fills the mirror; this character does not fit perfectly either with *Acla* or with *Aclodes* and the knowledge of other species will probably lead to the reunion of these two genera.

*Acla vicina*, new species

FIGURE 3, f

HOLOTYPE: Male; Cerro Azul, about 120 miles northwest of Pucallpa, Río Ucuyali, Perú, May 6, 1947, Schunke (USNM 62067).

MALE: Size medium; testaceous varied with brown, finely pubescent. Head short; vertex abruptly sloping; superior part adorned with four yellow lines which are united in front by three semicircular lines; another fine yellow line borders the internal face of the eye till the cheek, where it is united to the occiput by a short oblique line; frontal rostrum very narrow. Face yellow varied with brown. Eyes strongly projecting; ocelli very small, the anterior one at extremity of the rostrum, the lateral ocelli at base. Antennae brown with a few yellow rings. Palpi rather short, slender; 5th joint of the maxillary palpi feebly enlarged at apex which is straightly truncated.

Pronotum as long as wide in front, feebly widening backwards, with straight anterior and posterior margins; disk feebly convex, irregular, finely furrowed in the middle; lateral lobes with inferior margin ascending backwards, brown with anterior margin yellow. Abdomen brown; subgenital plate rather long, rounded at top. Genitalia rather short and similar to those of the preceding species (fig. 3,f).

Legs moderately long, varied with yellowish and brownish. Anterior and median tibiae thickened at base, mottled with brown; tibiae presenting three brown rings, the anterior ones nondilated at base, presenting on the internal face a small, nearly round foramen; apex of the anterior tibiae armed with two inferior spurs, the internal being the longer; median tibiae armed with three apical spurs; tarsi

long, chiefly the metatarsus which is brown with yellow base. Posterior femora rather short and thick at base, with almost null filiform apical part; external face obliquely striated with brown. Posterior tibiae presenting four brown rings, armed with four external, three internal spines which are short and placed quite in the apical part; margins strongly serrulated; external apical spurs very short, median and superior internal spurs longer, chiefly the median, which, however, does not exceed one-third the metatarsus; the latter is long, brown with yellow base, armed above with a row of five or six denticles, the apical spurs short.

Elytra extending to the apex of abdomen, rounded at apex; mirror very large, occupying more than two-thirds of the length of the elytron, divided by 13 undilated veins; diagonal vein very short; 1st chord rather long, almost straight and almost touching the mirror; 2nd chord short, strongly curved; anal field very short, the archet unbroken, simply undulated; oblique veins very close, about 12 in number (description made from the left elytron, the right one being absent), apical field very short with one vein only; lateral field dark brown, *Sc* plain.

Length 12.0 mm.; pronotum 2.8 mm.; posterior femur 11.0 mm.; elytra 7.0 mm.

REMARKS: Very close to *A. multivenosa* Chopard, from Costa Rica, but smaller with larger elytra and mirror occupying a more important place.

### Genus *Aclodes* Hebard, 1928

#### *Aclodes maculatum* (Caudell)

*Endacusta maculata* Caudell, Ins. Insc. Menstr., vol. 6, p. 66, 1918.

SPECIMENS EXAMINED: PERÚ: Pucallpa, Jan. 22, 1948 (1♂), Schunke; Tingo María, December 1949 (1♂), Allard.

### Family OECANTHIDAE

#### Key to the American genera

Posterior tibiae serrulated and armed with small spines on the superior margins.

*Oecanthus* Serville

Posterior tibiae serrulated without spines. . . . . *Neoxabea* Kirby

### Genus *Oecanthus* Serville, 1831

#### *Oecanthus peruvianus* Walker

*Oecanthus peruvianus* Walker, Catalogue of the . . . Dermaptera Saltatoria . . . in the British Museum, vol. 1, p. 95, 1869.

SPECIMENS EXAMINED: PERÚ: Chanchamayo, La Merced, Feb. 2, 1949 (1♀), Schunke.

## Family TRIGONIDIIDAE

## Key to the American genera

1. Last joint of maxillary palpi more or less dilated but of normal shape . . . 2  
    Last joint of maxillary palpi considerably expanded, foliaceous . . . . . 10
2. Elytra of male presenting a distinct mirror . . . . . 3  
    Elytral venation similar in both sexes . . . . . 7
3. Head flattened above; eyes horizontally lengthened; 5th joint of maxillary palpi very short . . . . . **Cyrtoxipha** Brunner  
    Head convex above; eyes vertically lengthened; 5th joint of maxillary palpi longer . . . . . 4
4. Form extremely slender; posterior metatarsi nearly twice as long as the other joints together . . . . . **Macroanaxipha** Hebard  
    Not so slender; posterior metatarsi shorter . . . . . 5
5. Anterior tibiae without tympana; size very small . . . . . **Falcicula** Rehn  
    Anterior tibiae with more or less distinct tympana; size larger . . . . . 6
6. Auditory tympana linear, imperforate; tegmina corneous, the veins poorly defined. Color of insect bright . . . . . **Symphyloxiphus** Rehn  
    Auditory tympana oval; tegmina membranaceous. Color of insect dull yellow or brownish to blackish . . . . . **Anaxipha** Saussure
7. Elytra covered with a fine pubescence . . . . . **Hebardinella** Chopard  
    Elytra without hairs on the dorsal surface . . . . . 8
8. Elytral veins quite straight, parallel, projecting . . . . . 9  
    Elytral veins less projecting, more or less oblique and diverging.  
    **Metioche** Stål
9. Posterior legs abnormally long . . . . . **Estrellina** Hebard  
    Legs of normal length . . . . . **Rhienogryllus** Chopard
10. Head and pronotum very elongate; coloration more or less metallic; pronotum without pubescence . . . . . **Cranistus** Stål  
    Head short; pronotum a little longer than wide . . . . . 11
11. Eyes feebly projecting; pronotum without hairy covering.  
    **Phyllopalpus** Uhler  
    Eyes more strongly projecting; pronotum with hairy covering.  
    **Phylloscyrtus** Guerin

Genus *Cyrtoxipha* Brunner, 1873*Cyrtoxipha pernambucensis* Rehn

*Cyrtoxipha pernambucensis* Rehn, Proc. Acad. Nat. Sci. Philadelphia, vol. 72, p. 283, pl. 11, fig. 39, 1920.

SPECIMENS EXAMINED: PERÚ: Pucallpa, Jan. 29, 1948 (1♀), Feb. 1, 1948 (1♀), Schunke; Tingo María, Nov. 14, 1949 (1♀), Allard.

Genus *Anaxipha* Saussure, 1874*Anaxipha peruviana* Saussure

## FIGURE 3,g

*Cyrtoxipha peruviana* Saussure, Mission scientifique au Mexique . . . . Recherches zoologiques, pt. 6, section 1 (Orthoptères), p. 378, 1874.

SPECIMENS EXAMINED: BOLIVIA: Blanca Flor, January 1922 (1♀), Mann; Huachi, September 1921 (1♀), Mann; Mapiri, September 1921 (1♂), Mann; Tumupasa, September 1921 (1♂), Mann. PERÚ: Chanchamayo, Apr. 26, 1948 (1♀), June 3, 1948 (1♂), Schunke; Divisoria, 1947 (1♀), 1948 (1♂), Dec. 4, 1947 (1♀), Feb. 15, 1948 (1♂), Schunke; Tingo María, November 1949 (1♂), December 1949 (2♂♂, 1♀), January 1950 (3♂♂, 6♀♀), February 1950 (1♂, 1♀), Feb. 11, 1950 (1♂), Feb. 14, 1950 (1♀), Feb. 19, 1950 (1♂, 1♀).

REMARKS: Both the Bolivian and Peruvian series include macropterous as well as micropterous specimens. Several micropterous ones from Tingo María are intensively colored.

*Anaxipha conspersa* (Bruner)

FIGURE 3,h,p

*Cyrtoripha conspersa* Bruner, Ann. Carnegie Mus., vol. 10, p. 406, 1916.

SPECIMENS EXAMINED: BOLIVIA: Coroico (1♂); Huachi, September 1921 (1♂), Mann; Tumupasa, December 1921 (1♀), Mann. PERÚ: Fundo Sinchona, Aug. 5, 1947 (1♀), Schunke; Pucallpa, Jan. 10, 1948 (1♂), Schunke.

*Anaxipha maxima* (Bruner)

FIGURE 3,i,n

*Cyrtoripha maxima* Bruner, Ann. Carnegie Mus., vol. 10, p. 407, 1916.

SPECIMENS EXAMINED: BOLIVIA: Reyes (1♀), Mann; Rosario, November 1921 (1♂), Mann.

*Anaxipha ruficeps*, new species

HOLOTYPE: Male; Tingo María, Perú, Feb. 14, 1950, Allard (USNM 62068).

MALE: Slender, of a very light general coloration. Head somewhat flattened above, adorned with four wide, rufous bands, uniting in front a little before the extremity of the rostrum; this rufous tint is bordered with an opaque, yellow band. Face as long as wide, pale yellow. Eyes projecting, rounded. Antennae yellow with 1st joint blackish brown. Palpi yellow; 4th joint of maxillary palpi shorter than 3d, 5th large, triangular, rather strongly enlarged at apex.

Pronotum narrowing in front; disk yellow, adorned in the middle with a wide brown band with a fine median yellow line; lateral lobes yellow with a rufous band in the superior part, inferior margin straight, anterior margin a little rounded. Abdomen yellow; genitalia almost alike those of *peruviana*.

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FIGURE 1.—Holotypes of: a, *Hygronemobius longespinosus*, new species, female; b, *Rhizonogryllus annulipes*, new species, male; c, *Prosthacusta amplipennis*, new species, male; d, *Diatrypa allardi*, new species, male. Drawn by Arthur D. Cushman, Entomology Research Branch, U. S. Department of Agriculture.



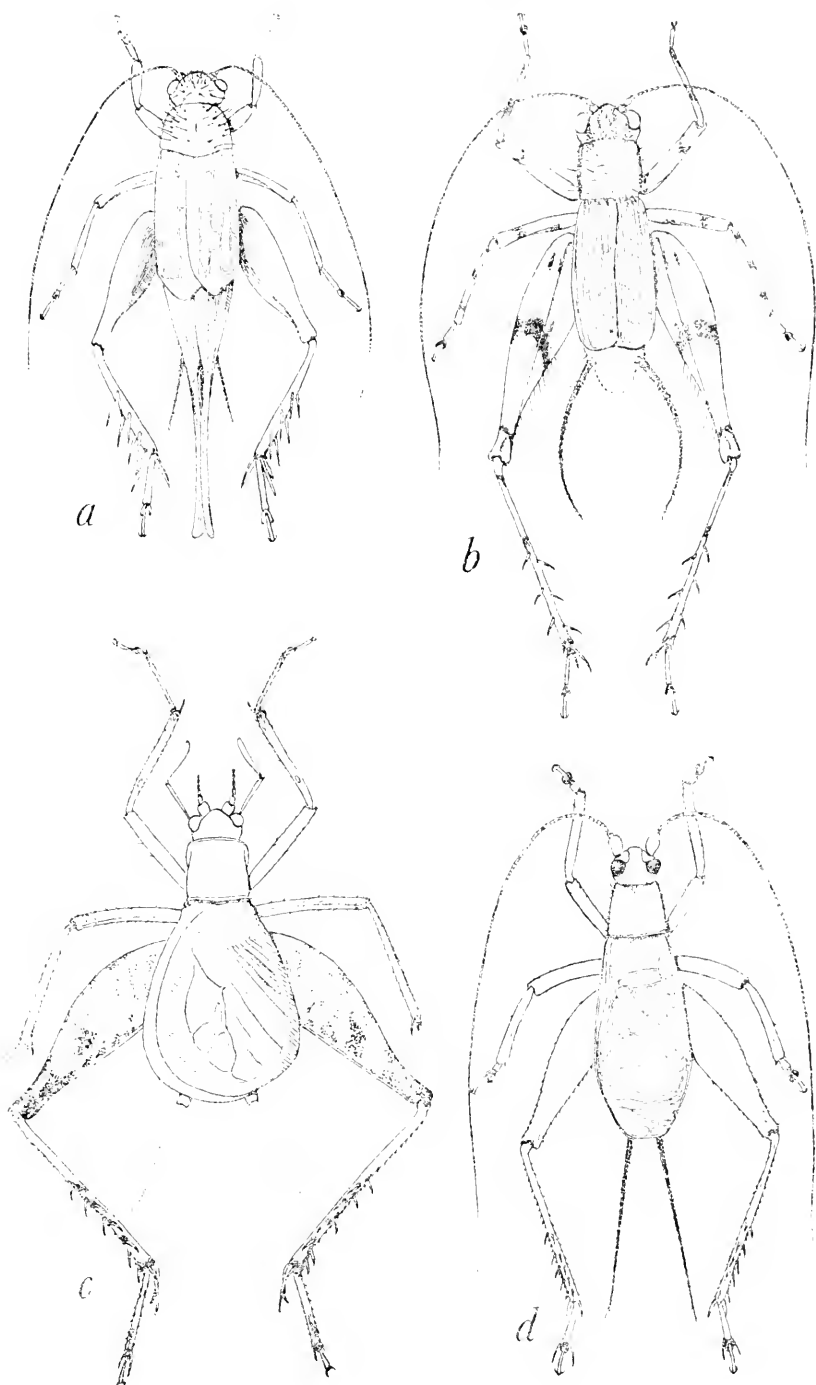


FIGURE 1.—For explanation see facing page.

Legs long and slender. Anterior tibiae rather strongly widening almost to the middle, perforated with two large, oval tympana; 2d and 3d joints of the tarsus grayish brown. Medium femora adorned with a rufous spot on each side a little before the apex. Posterior femora long and slender, yellow; spines of the tibiae long, grayish; apical spurs short, the two internal ones wide, furrowed beneath.

Elytra strongly exceeding the apex of abdomen, rather narrow; mirror large, longer than wide by a quarter; diagonal vein rather long, strongly curved at base, then very close and almost parallel to the

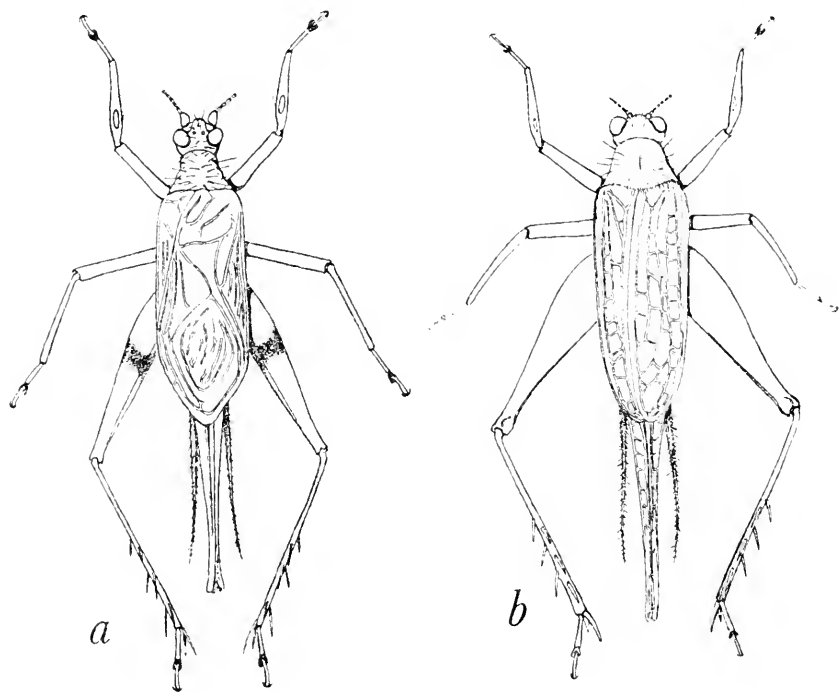


FIGURE 2.—Holotypes of: *a*, *Anaxipha nigerrima*, new species, male; *b*, *Melioche boliviana*, new species, male. Drawn by Arthur D. Cushman, Entomology Research Branch, U. S. Department of Agriculture.

oblique vein; coloration of a very pale, almost transparent yellow, with a few brown spots in the anal field, at extremity of the chords and quite at apex of the elytron; lateral field transparent with two veins. Wings long, grayish.

Length of body 6.5 mm.; length with wings 11.5 mm.; elytra 5.5 mm.; posterior femur 5.2 mm.

REMARKS: This species is remarkable by a rather narrow shape and a very pale general coloration with a well marked pattern on the head and elytra. The genitalia are almost similar to those of *A. peruviana*.

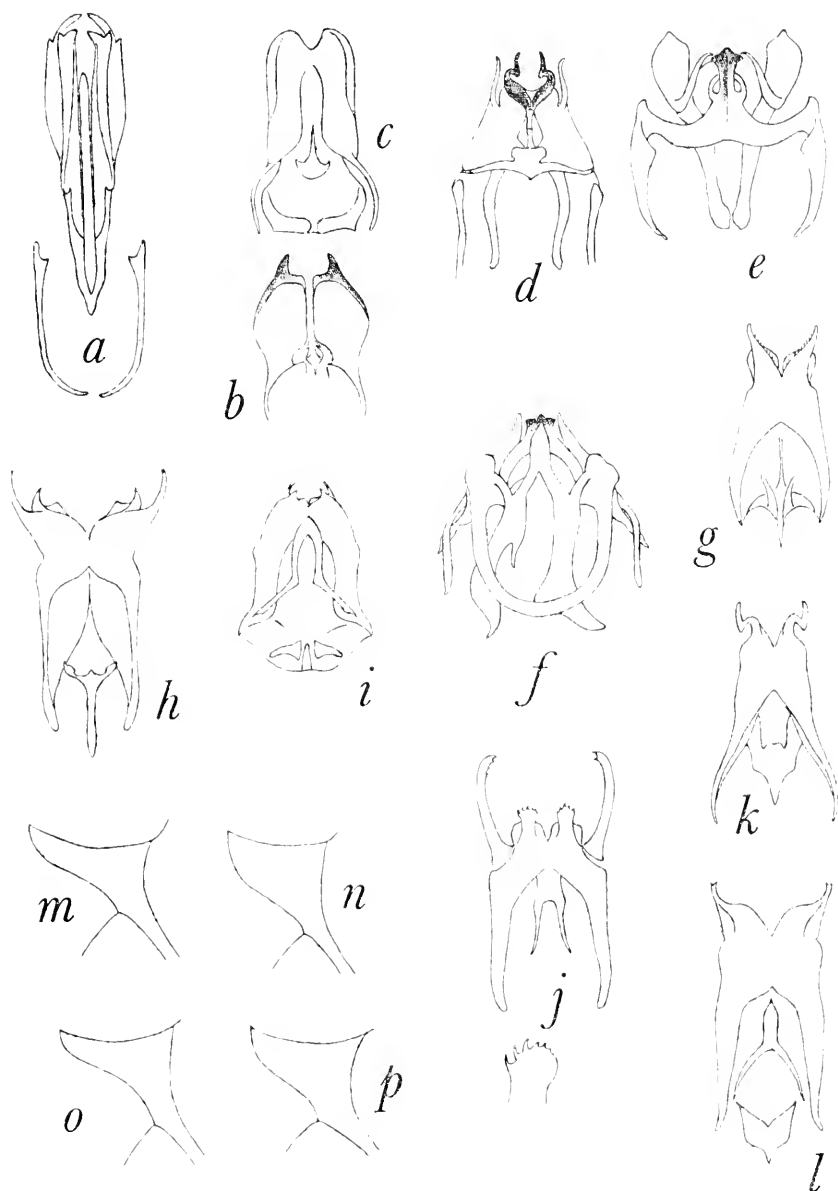


FIGURE 3.—Male genitalia (unless otherwise noted) of: *a*, *Acheta fulvastra*, new species; *b*, *Pteronemobius schunkei*, new species; *c*, *P. cubensis* Saussure; *d*, *Prosthacusta amplipennis*, new species; *e*, *Acla reticulata*, new species; *f*, *A. vicina*, new species (inferior part); *g*, *Anaxipha peruviana* Saussure; *h*, *A. conspersa* Bruner; *i*, *A. maxima* Bruner; *j*, *A. soror*, new species; *k*, *A. infirmenotata*, new species; *l*, *A. smithi* Saussure; *m-p*, oblique vein, diagonal vein, and anterior part of the mirror of: *m*, *Anaxipha soror*, new species; *n*, *A. maxima* Bruner; *o*, *A. infirmenotata*, new species; *p*, *A. conspersa* Bruner.

*Anaxipha soror*, new species

FIGURE 3,j,m

HOLOTYPE: Male; Tingo María, Perú, Feb. 11, 1950, in jungle. Allard (USNM 62029).

MALE: A large species, of the *conspersa-maxima* group; coloration uniformly dark testaceous. Head a little wider than pronotum in front, feebly flattened above. Eyes rounded. Antennae broken, the basal joints yellowish. Palpi testaceous; 4th joint of maxillary palpi shorter than 3d, 5th triangular, brown, feebly obliquely truncated at apex.

Pronotum transverse, rather strongly narrowing in front, provided with long bristles; lateral lobes yellowish with straight inferior margin, much-rounded anterior angle.

Legs relatively short, very pubescent. Anterior and median femora adorned with a brown ring before the apex; anterior tibiae moderately swollen at base perforated with two large, oval tympana. Posterior femora rather strongly dilated at base, without filiform apical part; tibiae spotted with brown at base of the spines; apical spurs strongly pubescent, the two large internal ones relatively short and thick.

Elytra extending a little farther than the abdominal extremity; mirror large ( $2.6 \times 3.2$  mm.); diagonal vein regularly bisinuated; lateral field with three veins; space between the Sc and the first vein very wide, regularly divided by vertical veinlets. Wings very long.

Length of body 6.8 mm.; length with wings 11 mm.; posterior femur 5.5 mm.; elytra 6.0 mm.

*Anaxipha infirmenotata*, new species

FIGURE 3,k,o

HOLOTYPE: Male; Tingo María, February 1950, Allard (USNM 62070),

DESCRIPTION: Very close to the preceding. Head rather strongly darkened above; 4th joint of the maxillary palpi almost equal to the 3d, 5th very large and chiefly very wide at apex, which is straightly truncated. Pronotum rather strongly narrowing in front; middle of the disk adorned with a large, brown, irregular spot; lateral lobes yellow with a few small brown spots. Anterior and median legs a little longer than in the preceding species; femora adorned with a

FIGURE 4.—Male genitalia (unless otherwise noted) of: a, *Anaxipha stolzmanni* Bolivar; b, *A. allardi*, new species, viewed from above; c, same, inferior side; d, *A. nigripennis*, new species; e, *A. nigerrima*, new species; f, *A. schunkei*, new species; g, *Metioche boliviiana*, new species; h, *M. peruviana*, new species; i, maxillary palpus of *M. peruviana*; j, maxillary palpus of *M. boliviiana*; k, *Rhcnogryllus annulipes*, new species; l, *Eneopteroides flavifrons*, new species; m, *Diatrypa pallidilabris* Chopard; n, *D. allardi*, new species; o, *D. latipennis*, new species; p, *D. schunkei*, new species.

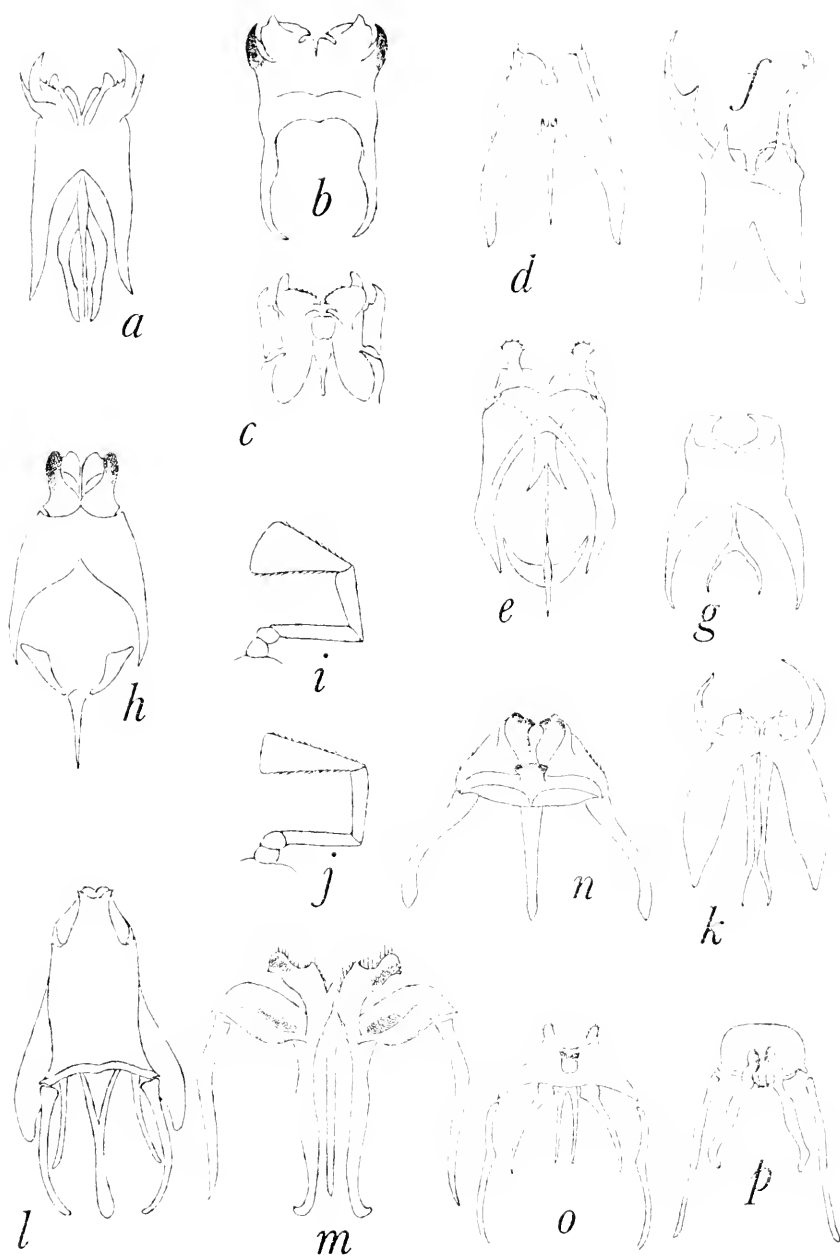


FIGURE 4.—For explanation see facing page.

brown ring a little before the apex; anterior tibiae strongly enlarged at base to the middle; auditory foramina very large, spotted with brown above. Posterior legs wanting. Elytra extending beyond the apex of abdomen; coloration of a dark amber with a few weak brown spots on the chords and at apex; mirror very large,  $1\frac{1}{4}$  times as long as wide; diagonal vein thickened and strongly curved at base, feebly convex after; the chord along the internal margin of the elytron very thick. Wings very long, brownish.

Length of body 7.5 mm.; length with wings 14.5 mm.; elytra 8.0 mm.

The five species of the group *consersa-maxima* are close and may be distinguished by the following key:

1. Diagonal vein curved at base only, very close and almost parallel to the oblique vein . . . . . **rufaceps**  
     Diagonal vein bisinuated, not at all parallel to the oblique vein . . . . . 2
2. Mirror nearly as wide as long; diagonal vein very distant from the oblique vein; posterior femora strongly spotted with brown . . . . . **consersa**  
     Mirror longer than wide by a quarter; diagonal vein not so distant from the oblique vein . . . . . 3
3. Last joint of maxillary palpi strongly enlarged at top . . . . . 4  
     Last joint of maxillary palpi not so wide at apex; diagonal vein quite regularly bisinuated . . . . . **soror**
4. Diagonal vein strongly curved . . . . . **maxima**  
     Diagonal vein very feebly curved . . . . . **infirmenotata**

*Anaxipha smithi* (Saussure)

FIGURE 3,l

*Cyrtoxiphus smithi* Saussure, in Godman and Salvin, *Biologia Centrali-Americana*, Orthoptera, vol. 1, p. 236, 1897.

SPECIMENS EXAMINED: BOLIVIA: Blanca Flor, January 1922 (1♂), Mann; Cachuela, March 1922 (1♂), Mann; Rurrenabaque, January 1922 (1♂), Mann. PERÚ: Pucallpa, Feb. 3, 1948 (1♀), Mar. 2, 1948 (2♂♂, 2♀♀), Schunke; Tingo María, November 1949 (1♂), Allard.

*Anaxipha stolzmanni* (Bolivar)

FIGURE 4,a

*Cyrtoxiphus stolzmanni* Bolivar, *Anal. Soc. Española Hist. Nat.*, vol. 10, p. 475, 1881.

SPECIMENS EXAMINED: BOLIVIA: Blanca Flor, January 1922 (1♂), Mann. PERÚ: Chanchamayo, Apr. 29, 1948 (1♂), May 5, 1948 (1♂), Schunke; Pucallpa, Oct. 17, 1947 (1♀), Schunke; Tingo María, November 1949 (1♂, 2♀♀), December 1949 (1♀), February 1950 (1♀), Allard.

*Anaxipha championi* (Saussure)

*Cyrtoxiphus championi* Saussure, in Godman and Salvin, *Biologia Centrali-Americana*, vol. 1, p. 236, pl. 11, fig. 41, 1897.

SPECIMENS EXAMINED: BOLIVIA: Tumupasa, December 1921 (1♂), Mann.

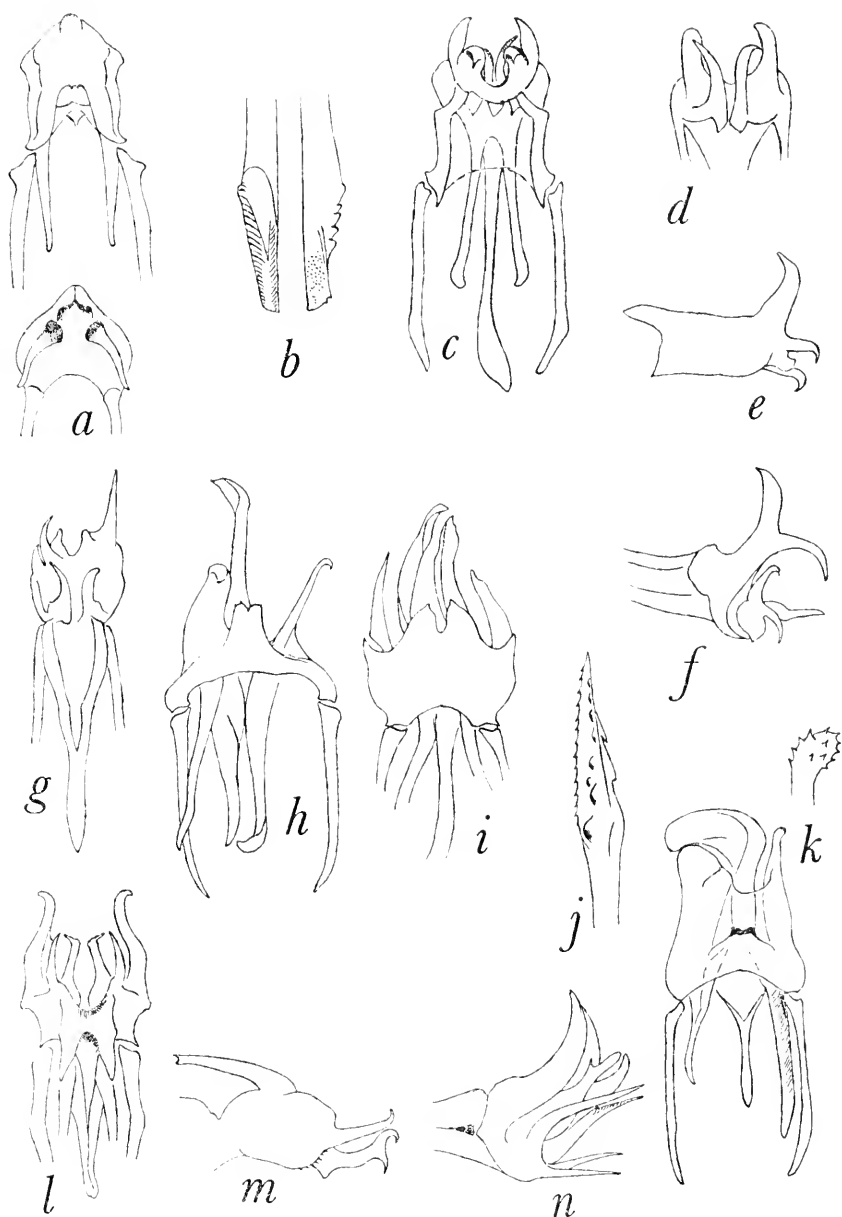


FIGURE 5.—Male genitalia (unless otherwise noted) of: *a*, *Amblyrhetus nodifer*, new species, upper figure as seen from above, lower figure as seen from beneath; *b*, extremity of ovipositor of *Amblyrhetus nodifer*, new species, left figure as seen from above, right figure as seen from beneath; *c*, *Aphonomorphus telskii* Saussure, viewed from above; *d*, same, inferior part; *e*, same, side view; *f*, *A. stipatus*, new species; *g*, *A. socius*, new species; *h*, *S. dissimilis*, new species; *i*, *A. obscurus*, new species; *j*, extremity of ovipositor of *A. obscurus*, new species; *k*, *A. deceptor*, new species; *l*, *m*, *A. schunkei*, new species *n*, *A. allardi*, new species.

*Anaxipha gracilis* (Scudder)

*Trigonidium gracile* Scudder, Proc. Boston Soc. Nat. Hist., vol. 12, p. 331, 1869.

SPECIMENS EXAMINED: PERÚ: Pucallpa, 1948 (1♀), Schunke.

*Anaxipha annulipes* Hebard

*Anaxipha annulipes* Hebard, Proc. Acad. Nat. Sci. Philadelphia, vol. 76, p. 233, pl. 10, fig. 17, 1924.

SPECIMENS EXAMINED: PERÚ: Tingo María, December 1949 (1♀), Allard.

*Anaxipha allardi*, new species

FIGURE 4,*b,c*

Types: Holotype: Male; Tingo María, Perú, November 1949, Allard (USNM 62071). Allotype: Tingo María, Perú, December 1949, Allard (♀) (USNM).

DESCRIPTION: Small, yellow varied with light brown drawings. Head short, convex, adorned with a wide brown band which is divided by a fine longitudinal yellow line, and a narrower brown band behind each eye; frontal rostrum provided with two rows of five or six long bristles. Face scarcely longer than wide, yellow adorned with two brown spots along the internal margin of the antennal sockets which are separated only by a narrow yellow band; in the middle these spots are yellow; beneath each eye there is a brown band extending a little on the side of the clypeus; the center of the latter is spotted with brown. Eyes rounded, rather strongly projecting; ocelli small, the anterior one a little before the extremity of the rostrum. Antennae light brownish. Palpi yellow; 4th joint of the maxillary palpi shorter than 3d, 5th widely triangular, straightly truncated at apex.

Pronotum transverse, very feebly narrowing in front, with anterior and posterior margin straight; disk feebly convex, faintly pubescent; general coloration brown with a narrow yellow line in the middle and two wide bands of the same color on the sides; anterior and posterior margins narrowly yellow with a series of small brown spots; lateral lobes yellow with small brown spots. Legs yellow, spotted with light brown, pubescent. Anterior and median femora with a weak brown

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FIGURE 6.—*a-d*, Male genitalia of *Aphonomorphus adjunctus*, new species: *a*, as seen from above, holotype; *b*, same, paratype; *c*, inferior part, holotype; *d*, side view, holotype. *e*, Extremity of ovipositor of *A. adjunctus*, new species. *f-i*, Reticulation of middle of elytron in: *f*, *Euaphonus peruvianus* Saussure, *g*, *Aphonomorphus stipatus*, new species; *h*, *A. schunkei*, new species; *i*, *A. adjunctus*, new species. *j*, Genitalia of male *Euaphonus peruvianus* Saussure from Chanchamayo; *k*, extremity of *E. peruvianus* from Pucallpa; *l*, genitalia of male *Paraphonus vicinus*, new species; *m*, male *Rhipipteryx difformipes*, new species, abdominal extremity; *n*, same, median leg; *o*, *Rhipipteryx vicinus*, new species, abdominal extremity of male; *p*, *Rhipipteryx femoratus*, new species, anterior leg; *q*, same, abdominal extremity of male; *r*, *R. schunkei*, new species, abdominal extremity of male.



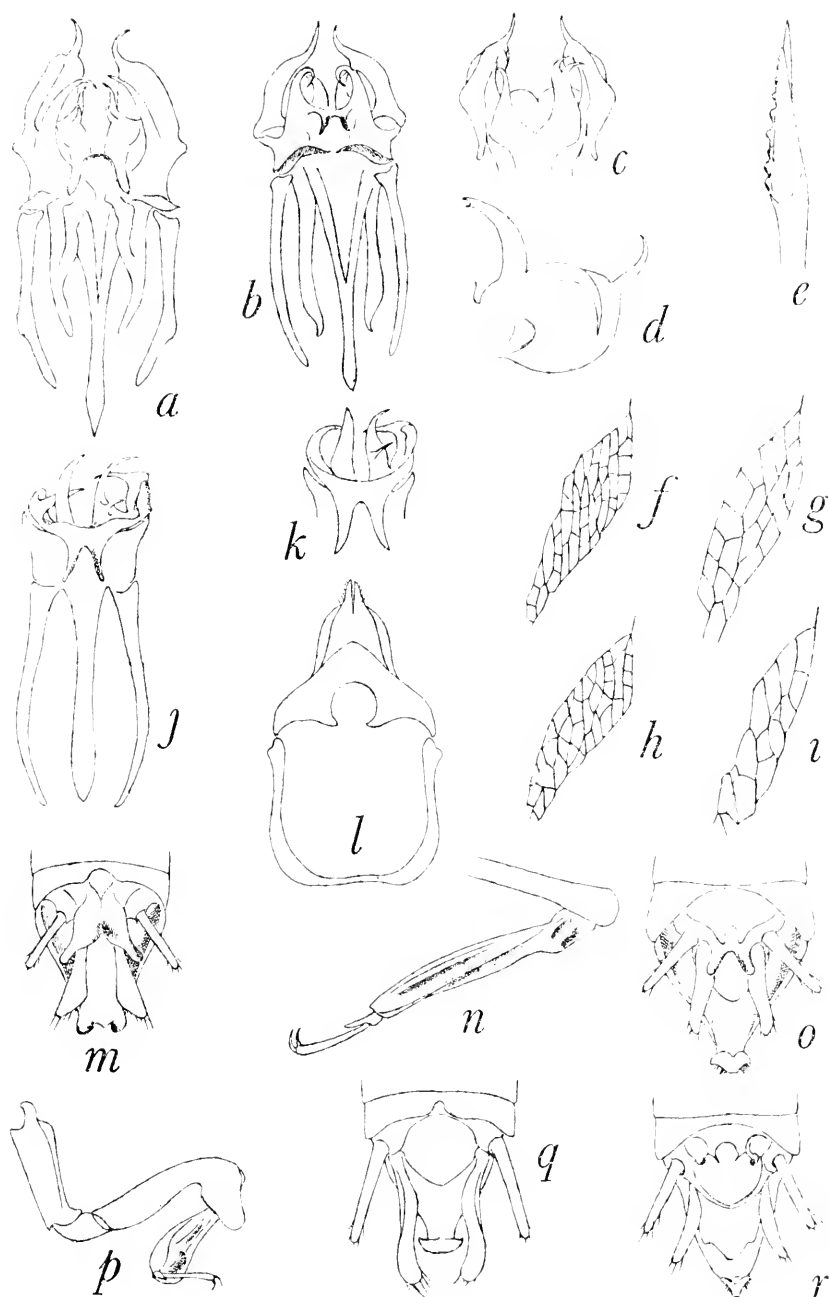


FIGURE 6. - For explanation see facing page.

ring near the apex; anterior tibiae perforated with two foramina in the female (macropterous condition), without these tympana in the male (micropterous). Posterior femora relatively short and thick, adorned on the external face with a longitudinal brown band along the inferior margin and numerous oblique bands of the same color, more or less anatomosed. Spines of the posterior tibiae long, spotted with brown at base and at apex.

**MALE:** Abdomen blackish beneath; subgenital plate with posterior margin narrowly yellow, presenting a slight median projection. Elytra extending a little beyond the abdominal extremity, yellowish, translucent; mirror very large,  $1\frac{1}{2}$  times as long as wide, with anterior angle strongly acute, the widest part much beneath the middle; diagonal vein very short, sinuated; lateral field nearly transparent, with three veins. No wings.

**FEMALE:** Elytra very pale yellow, translucent; the part of the left elytron which is covered by the right one is smooth, completely transparent; dorsal field with four rather strong, almost longitudinal veins, which are separated by feebly marked false vein; transverse veinlets rather numerous, strong, forming large, rectangular, rather regular areolae. Wings lengthily caudate. Abdomen yellowish. Ovipositor rather short, wide, with apical valves smooth, occupying almost half the total length.

**DIMENSIONS** (in millimeters): Length of body 5.0; length with wings, ♀ 9.5; posterior femur, 4.2; elytra, ♂ 3.7, ♀ 3.5; ovipositor, 2.2.

**REMARKS:** A small species well characterized by its relatively short shape, its thick posterior femora, its coloration pale with well marked light brown drawings.

*Anaxipha latefasciata*, new species

**HOLOTYPE:** Female; Rosario, Lake Rogagua, Bolivia, Oct. 28–Nov. 9, 1921, Mann (USNM 62072).

**FEMALE:** Small, yellow with a wide brown band extending from the head to the extremity of the elytra. Head short, flattened, brown above; face longer than wide, yellow. Eyes feebly lengthened longitudinally. Antennae and palpi yellow; 1st joint of antennae spotted with brown on the internal face; 4th joint of maxillary palpi much shorter than 3d, 5th short and wide, triangular, straightly truncated at apex.

Pronotum feebly narrowing in front, with anterior margin convex, posterior margin straight; disk rather strongly convex, furrowed in the middle, feebly pubescent, shining; all the median part is occupied by the longitudinal brown band; lateral lobes yellow, with straight inferior margin, rounded anterior angle. Abdomen brown above,

yellow beneath. Ovipositor rather long; apical valves occupying half the total length, very finely denticulated.

Legs yellow. Anterior tibiae perforated with two oval tympana.

Elytra extending to the apex of abdomen, yellow shining with the wide brown band which extends on the whole length, with veins widely separated and somewhat projecting; dorsal field with four diverging veins, the internal rather joining the 2d; transverse veinlets very few, forming a few irregular, large cells; lateral field with four veins, one of which is incomplete. Wings yellowish, caudate.

Length of body 4.2 mm.; length with wings 8 mm.; posterior femur 3.5 mm.; elytra 3 mm.; ovipositor 1.6 mm.

REMARKS: This species presents a rather irregular elytral venation as in the species of the *nitida* group; the coloration is characteristic. The shape of the eyes and palpi is somewhat cyrtoxiphoid.

*Anaxipha nigripennis*, new species

FIGURE 4,*d*

HOLOTYPE: Male; Chanchamayo, Department of Junin, Perú, elevation 1,200 meters, Apr. 29, 1948, Schunke (USNM 62073).

MALE: Wholly blackish with yellow legs. Head dark brown, feebly flattened above; face black, shining. Eyes rounded, projecting, scarcely lengthened dorsoventrally. Antennae yellow with two first joints blackish. Palpi yellow; last joint of maxillary palpi moderately widened at apex, darkened.

Pronotum very wide and strongly narrowing in front, furrowed in the middle; lateral lobes with straight inferior margin, much-rounded anterior angle. Abdomen blackish; subgenital plate feebly truncated at apex.

Anterior legs wanting. Median legs yellow with a few small rufous brown spots towards the apex of femora and on the tibiae. Posterior femora rather thick, presenting fairly numerous small brown spots; spines and apical spurs of the tibiae brown, the spurs rather short; metatarsi yellow with brown extremity; 2d joint brown.

Elytra blackish brown; mirror large, as wide as long, the internal margin regularly rounded; diagonal vein very weakly sinuated, very close to the oblique vein towards the apex; lateral field blackish with three veins, the first of which is strongly diverging from the *Sc*; the space between these two veins is divided by six straight veinlets. No wings.

Length of body 6.8 mm.; posterior femur 5.0 mm.; elytra 4.8 mm.

REMARKS: This species is close to *platyptera* Hebard; the general shape is a little less wide and the posterior femora have no brown band in the middle.

*Anaxipha nigerrima*, new species

FIGURES 2,a, 4,e

Types: Holotype: Female; Fundo Sinchono, about 40 miles southwest of Pucallpa, Río Ucuyali, Perú, Aug. 14, 1947, Schunke (USNM 62074). Allotype: Same locality as holotype, Aug. 29, 1947, Schunke (♂) (USNM). Paratypes: Same locality as holotype, Sept. 5, 1947, Schunke (1♂); Divisoria, elevation 1,600 meters, about 80 miles southwest of Pucallpa, Río Ucuyali, Perú, 1947, Schunke (1♀); Tingo María, Perú, December 1949, Allard (1♂) (USNM).

FEMALE: Blackish, shining with yellowish legs, the posterior femora adorned in the middle with a blackish brown ring. Head blackish brown, shining, almost glabrous; vertex sloping, flattened. Face brown. Eyes projecting, rounded. Antennae yellow with blackish two first joints. Palpi blackish; 4th joint of maxillary palpi much shorter than 3d, 5th scarcely equal to the 3d, triangular.

Pronotum blackish with a fine whitish pubescence and some long black bristles, chiefly along the anterior margin; general shape rather neatly narrowing in front; anterior margin rather convex, posterior margin feebly sinuated; disk rather strongly convex, feebly furrowed in the middle; lateral lobes with straight inferior margin, much-rounded anterior angle. Abdomen dark brown. Ovipositor rather short, with apical valves equaling almost half the total length, very finely denticulated. Cerci brownish with yellow base.

Legs rather long. Anterior femora yellowish with a fine black pubescence, feebly darkened at apex; tibiae blackish, with strongly widened basal half; auditory foramina large, chiefly the internal; tarsi blackish, the metatarsus very long, the 3d joint very short. Median femora like the anterior ones; tibiae not so strongly darkened. Posterior femora long, rather narrow, yellowish, with a rather wide blackish ring in the middle; tibiae yellowish, darkened at top, with rather short grayish spines; apical spurs short, dark gray, the superointernal wide, acute at apex, extending only to the middle of the metatarsus; the latter is long, grayish with yellowish base.

Elytra as long as abdomen, rather narrow, wholly of a shining black; veins of the dorsal field rather projecting, oblique, widely separated, plain, uniting at apex, except the *Cu* which is furcate near the extremity; transverse veinlets very distant; lateral field black, with three plain, parallel veins. Wings caudate; anterior field blackish with white apex.

Length of body 6.8 mm.; length with wings 12.0 mm.; posterior femur 5.1 mm.; elytra 5.0 mm.; ovipositor 2.0 mm.

MALE (allotype): Head, pronotum, and legs as in the female. Elytra with parallel margins; mirror large and wide,  $1\frac{1}{4}$  times as long

as wide; chords long, parallel, nearly straight; diagonal vein rather short, convex, very close to the oblique vein towards the apex.

Length of body 7.0 mm.; length with wings 12.5 mm.; posterior femur 5.5 mm.; elytra 6.0 mm.

This species is close to *A. nitida* Chopard, from French Guiana; it is larger, without any trace of the whitish spot which exists towards the middle of the elytra, the elytral venation is a little more regular. It also differs from *annulipes* Hebard by the absence of a second brown ring on the posterior femora and by the wings, which are whitish at top.

*Anaxipha schunkei*, new species

FIGURE 4, f

HOLOTYPE: Male; Fundo Sinchono, about 40 miles southwest of Pucallpa, Río Ucuyali, Perú, Aug. 27, 1947, Schunke (USNM 62075).

MALE: Dark testaceous with a few feeble light brown spots on the legs and elytra. Head rufous, a little flattened above; frontal rostrum as wide as the 1st joint of antennae, a little rounded at top. Face as long as wide, testaceous, smooth. Eyes slightly lengthened antero-posteriorly; ocelli very small, the anterior one placed a little before the extremity of the rostrum. Antennae yellow with small light brown rings. Palpi yellowish; 5th joint of the maxillary palpi large, triangular, somewhat darkened at apex, which is straightly truncated.

Pronotum rufous, slightly narrowing in front; disk feebly convex, furrowed in the middle; lateral lobes concolorous, with convex inferior margin, much-rounded anterior angle. Abdomen testaceous. Genitalia somewhat asymmetric, forming two very long horns.

Legs rather long, yellowish covered with a fine brown pubescence. Anterior and median femora very narrowly darkened at apex and adorned a little before with a small brown ring; anterior tibiae very feebly dilated at base, presenting on the external face a rather small oval tympanum; superior face adorned with a small brown spot at base and another a little larger about the anterior third; apex armed with two inferior spurs; apex of the metatarsus and second joint of the tarsus brown. Median legs similar to the anterior ones. Posterior femora moderately swollen, adorned with three feebly marked brown bands, one a little before the middle, the second about the apical fourth, the third at apex. Posterior tibiae and extremity of the legs in very bad state.

Elytra large, extending a little beyond the abdominal extremity; their color is amber yellow, adorned with brownish spots in the anterior angle of the mirror, on the chords, near the posterior margin, and towards the middle of the cubital vein; mirror very large, nearly as long as wide; diagonal vein short, sinuated. No wings.

Length of body 5.0 mm.; posterior femur 5.0 mm.; elytra 4.2 mm.

REMARKS: This species belongs to the *simulacrum* type; the anterior tibiae being very feebly dilated and the eyes almost cyrtoxiphoid. The shape of the genitalia is very peculiar.

### Genus *Phylloscyrtus* Guerin, 1844

#### *Phylloscyrtus cicindeloides* Gerstaecker

*Phylloscyrtus cicindeloides* Gerstaecker, Stett. Ent. Zeit., vol. 24, p. 428, 1863.

SPECIMENS EXAMINED: BRAZIL: Manaus (1 ♂), Merrill.

#### *Phylloscyrtus elegans* Guerin

*Phylloscyrtus elegans* Guerin, Iconographie du règne animal de G. Cuvier . . . , p. 333, 1844.

SPECIMENS EXAMINED: PERÚ: Tingo María, December 1949 (2♀♀), Allard.

### Genus *Metioche* Stal, 1877

#### *Metioche boliviana*, new species

FIGURES 2,b, 4,g,j

TYPES: Holotype: Male; Blanca Flor, Río Beni, Bolivia, Mann (USNM 62076). Allotype: Rurrenabaque, Río Beni, Bolivia, November 1921, Mann (♀) (USNM).

MALE: Rather dark brownish, feebly pubescent. Head a little wider than pronotum in front, without any ornament; vertex sloping; frontal rostrum as wide as 1st antennal joint. Face a little longer than wide, brown, smooth. Eyes rather strongly projecting, rounded. Antennae and palpi brown.

Pronotum with straight anterior and posterior margins, nearly parallel sides; disk convex, furrowed in the middle, presenting a fine whitish pubescence and long bristles on the sides; lateral lobes of the same color as the disk. Abdomen brownish, pubescent; subgenital plate narrowing a little posteriorly. Genitalia short, in the shape of a very plain tong.

Legs of a dirty yellow; anterior and median femora with a feebly marked brown ring before the apex; posterior femora without any ornament; anterior tibiae perforated with two foramina. Posterior tibiae somewhat darkened with rather long spines; superointernal apical spur longer than half the metatarsus.

Elytra long and narrow, with parallel and rather regularly spaced longitudinal veins; *Cu* furcate near the apex; transverse veinlets rather regular, scarce; lateral field darker than the dorsal field, presenting three regularly spaced veins. Wings rather long, brown.

Length of body 5.7 mm.; length with wings 8.5 mm.; posterior femur 4.5 mm.; elytra 4.2 mm.

**FEMALE:** Almost similar to the male. Maxillary palpi yellowish, with 4th joint a little shorter than the 3d, 5th long, triangular. Elytral venation similar to the male but the veins a little less straight, curved at base and at apex, *Cu* more neatly furcate. Ovipositor short and wide, the apical valves occupying half the total length.

Length of body 5.4 mm.; length with wings 8.7 mm.; posterior femur 4.5 mm.; elytra 4.2 mm.; ovipositor 2 mm.

*Metioche peruviana*, new species

FIGURE 4,*h,i*

**HOLOTYPE:** Male; Tingo María, Perú, February 1950, Allard (USNM 62077).

**MALE:** Very close to the preceding. Differing from it in the longer legs, the 5th joint of maxillary palpi shorter and wider and the shape of genitalia (fig. 4,*i*). The elytral venation is quite similar to that of the female of *boliviana*.

Length of body 5.7 mm.; length with wings 9.5 mm.; posterior femur 5 mm.; elytra 4.5 mm.

**Genus *Rhcnogryllus* Chopard, 1925**

*Rhcnogryllus annulipes*, new species

FIGURES 1,*b*, 4,*k*

**HOLOTYPE:** Male; Tingo María, Perú, February 1950, Allard (USNM 62078).

**MALE:** Light testaceous, varied with brown. Head a little wider than pronotum, feebly flattened above, adorned with four weak brown bands; frontal rostrum as wide as 1st antennal joint. Face triangular, as long as wide, rufous, smooth. Eyes rather strongly projecting, feebly lengthened dorsoventrally; ocelli very small. Antennae yellowish with small brown rings. Palpi yellowish, feebly darkened at apex; 4th joint of maxillary palpi shorter than 3d, 5th in the shape of a long triangle, moderately widened at apex which is straightly truncated.

Pronotum with parallel sides, anterior margin very feebly convex, bordered with long bristles; posterior margin straight; disk feebly convex, furrowed in the middle, testaceous with two brownish spots near the posterior margin; lateral lobes with straight inferior margin, adorned with a wide longitudinal brown band; surface covered with a rather abundant whitish pubescence and a few long bristles on the sides. Abdomen brownish above, yellow beneath. Cerci yellow.

Legs rather long, yellowish with brown rings. Anterior and median tibiae with a brown ring a little before the apex; tibiae with two brown rings, the anterior ones nonperforated, not at all dilated at base; extremity of the metatarsus and 2d tarsal joint brown. Posterior

femora rather thick, yellowish adorned with a wide brown ring towards the middle and another one quite near the apex; tibiae with three brown rings; tibial spines brown; external apical spurs yellow, internal spurs brown; metatarsi long, yellow with brown top, 2d joint brown.

Elytra extending almost to the apex of abdomen, testaceous with brown extremity; dorsal field presenting six quite straight, parallel projecting veins; transverse veinlets very few; lateral field with four regularly distant veins. No wings.

Length of body 5 mm.; posterior femur 4.6 mm.; elytra 2.7 mm.

REMARKS: This is the first species of the genus *Rhienogryllus* found in America.

## Family ENEOPTERIDAE

### Key to the American genera

1. Apical spurs of the posterior tibiae long, the median longer than the other two either side (*Encopterinae* group) . . . . . 2
- Externoapical spurs of the posterior tibiae very short, almost equal in length; internal spurs very different in length, the superior the longest (*Podoscirtinae* group) . . . . . 5
2. Posterior metatarsus long . . . . . 3
- Posterior metatarsus short . . . . . 4
3. Posterior femora very long; elytra extending beyond the apex of abdomen.

#### **Encoptera** Burmeister

Posterior femora rather short; elytra extending only to the apex of abdomen.

#### **Ponca** Hebard

4. Frontal rostrum three times as wide as the first antennal joint; elytra of male a little shorter than abdomen, with a perfect mirror . **Ligypterus** Saussure
- Frontal rostrum scarcely wider than the first antennal joint; male elytra without mirror . . . . . **Encopteroides**, new genus
5. Posterior tibiae armed with strong spines but without denticles at base or before the spines . . . . . **Stenogryllus** Saussure
- Posterior tibiae armed with spines and denticles . . . . . 6
6. Posterior tibiae armed with two or three spines towards the apex.

#### **Chremon** Rehn

Posterior tibiae armed with five or six spines occupying more than the distal half . . . . . 7

7. Body strongly elongate; posterior metatarsus long with two rows of denticles (anterior tibiae nonperforated; elytra of male small, without tympana).

#### **Cylindrogryllus** Saussure

General shape variable but not so elongate; posterior metatarsus rather short . . . . . 8

8. Elytra of the male provided with a mirror . . . . . 9
- Elytral venation similar in both sexes . . . . . 18
9. Head globular; vertex short, without rostrum, transversely carinate (anterior tibiae perforated either side) . . . . . **Phyllogryllus** Saussure
- Head with a prominent rostrum between the antennae . . . . . 10
10. Head vertical; mouth directed downwards . . . . . 11
- Head horizontal; mouth directed forwards (anterior tibiae perforated on the external face) . . . . . **Ectotrypas** Saussure





SPECIMENS EXAMINED: 45 specimens, including both sexes, of this very common species are included from the following localities: BOLIVIA: Covendo; Espia; Huachi; Rurrenabaque. BRAZIL: Manáos; Forteleza. PERÚ: Chanchamayo; Fundo Chela; Pucallpa; Tingo María.

*Eneoptera guyanensis* Chopard

*Eneoptera guyanensis* Chopard, Bull. Soc. Ent. France, vol. 36, p. 14, 1931.

SPECIMENS EXAMINED: BRAZIL: Manáos (1 ♂, 1 ♀), Merrill.

Genus *Eneopteroides*, new genus

DESCRIPTION: General aspect as in *Eneoptera*; legs shorter; frontal rostrum much narrower, scarcely wider than the first antennal joint; 5th joint of maxillary palpi in the shape of a very wide triangle. Anterior tibiae perforated on the internal face with a long foramen. Elytra of the male without a mirror.

TYPE OF GENUS: *Eneopteroides flavifrons*, new species.

*Eneopteroides flavifrons*, new species

FIGURE 4,l

HOLOTYPE: MALE; Pucallpa, Río Ucuyali, Perú, Dec. 9, 1947, Schunke (USNM 62079).

MALE: Head a little wider than the pronotum, short, vertex sloping; blackish brown above with four short yellow lines on the occiput; frontal rostrum scarcely wider than the 1st antennal joint, yellow. Face triangular, as long as wide, presenting between the eyes a wide yellow band; inferior part brown, shining. Palpi rather short, brown; 4th joint of the maxillary palpi equaling the 3d, feebly widening at apex; 5th joint very large, triangular with straight apical margin. Antennae yellow. Eyes rounded, rather strongly projecting; ocelli rather small, disposed almost on a straight line.

Pronotum transverse, feebly narrowing in front, with anterior margin feebly concave, posterior margin nearly straight; disk almost flat, brownish bordered on each side by a narrow yellow band; lateral lobes blackish with convex inferior margin. Abdomen yellowish above, brownish beneath; subgenital plate long, furrowed in the apical third only, slightly notched at apex. Cerci yellowish mottled with brown. Genitalia long and narrow, a little truncated at apex (fig. 4,l).

Legs short. Anterior femora almost black; tibiae thick, feebly compressed, dark brown, lighter above chiefly near the base; internal face presenting a rather large, oval, narrow auditory foramen; metatarsus extremely short, brown; 2d joint flattened, 3d long and slender, yellow. Median legs similar to the anterior ones but with the femora yellowish at base. Posterior femora short and thick, present-

ing on the external face a longitudinal brown band; inferior edges mottled with brown. Posterior tibiae strongly pubescent, armed with four spines on each margin, strongly serrulated at base and between the spines; external apical spurs very short; superointernal spur almost equal to the metatarsus, median spur a little shorter, inferior half as long as the superior; metatarsus very short, armed above with two strong external denticles, one internal; apical spurs very long, equal in length; 3d joint long and slender.

Elytra finely pubescent, brownish with the radial vein yellow; median vein mottled with yellow and brown; intercalated triangle blackish. Veins rather strongly marked, very oblique; five branches on the cubital vein, lost towards the apex in the reticulation; this is formed of long, narrow, rather regular areolae; lateral field very dark brown; *Sc* bearing six branches, the 3d branch is divided (on the left side only). Wings extending very little beyond the apex of elytra.

Length of body 17.5 mm.; length with wings 21.5 mm.; pronotum 2.6 mm.; width of pronotum 4.0 mm.; posterior femur 11.0 mm.; elytra 14.5 mm.

### Genus *Diatrypa* Saussure, 1874

#### *Diatrypa pallidilabris* Chopard

FIGURE 4,*m*

*Diatrypa pallidilabris* Chopard, Ann. Soc. Ent. France, vol. 81, p. 415, 1913.

SPECIMENS EXAMINED: PERÚ: Pucallpa, Feb. 20, 1948 (1♀), Schunke; Tingo María, December 1949 (1♀), February 1950 (1♂), Allard.

#### *Diatrypa allardi*, new species

FIGURES 1,*d*, 4,*n*

HOLOTYPE: Male; Tingo María, Perú, January 1950, Allard (USNM 62081).

MALE: Uniformly testaceous. Head flattened with frontal rostrum a little narrower than the 1st antennal joint, somewhat rounded at apex. Face as long as wide, yellowish. Eyes feebly projecting; ocelli very small. Antennae yellow with small brown rings. Palpi wanting.

Pronotum weakly narrowing in front, with anterior and posterior margins straight, ciliated; disk rather strongly convex, finely pubescent; lateral lobes darker than the disk, long with feebly sinuated inferior margin, rounded angles. Abdomen dark brown; subgenital plate rather short subtruncate at apex. Genitalia, small, narrowing, deeply notched at apex (fig. 4,*n*).

Legs of the same color as the body, pubescent. Anterior femora and tibiae short, compressed; tibiae feebly dilated at base, perforated with two oval tympana; metatarsi very short. Median legs a little longer than the anterior, almost of the same shape. Posterior femora rather short and thick, adorned in the middle of the external face with a longitudinal brown band; tibiae finely serrulated, armed with four yellow spines on each margin; external apical spurs very short; median and chiefly superointernal spur longer but not so long as half the metatarsus; the latter is rather long, very pubescent, almost carinate above, armed with four denticles placed on a single row; apical spurs rather long, chiefly the internal; 3d joint very slender.

Elytra extending somewhat beyond the abdominal extremity; anal field large; archet broken at right angle; mirror much wider than long, angulate in front, rounded backwards in the shape of a long oval, divided in the middle by a horizontal vein; diagonal vein short, feebly curved; chords parallel; seven feebly sinuated oblique veins; apical field rather short, presenting four veins and very few transverse veinlets; lateral field wrapping; *Sc* bearing nine branches; space between *Sc* and *R* crossed by regularly parallel veinlets. Wings not longer than the elytra.

Length of body 12.0 mm.; posterior femur 8.2 mm.; elytra 8.5 mm.; width of elytra 4.3 mm.

*Diatrypa latipennis*, new species

FIGURE 4,o

HOLOTYPE: Male; Tingo María, Perú, December 1949, Allard (USNM 62080).

MALE: Very close to the preceding but of a lighter color and with elytra more strongly widening backwards. General color of a light testaceous; pubescence very fine, rather abundant. Head flattened above; face as long as wide, testaceous. Antennae yellow with feebly marked small brown rings. Palpi testaceous; 4th joint of maxillary palpi shorter than 3d, 5th equaling the 3d, feebly enlarged and straightly truncated at apex. Pronotum feebly narrowing in front, with posterior margin feebly convex. Legs as in *allardi*. Elytra amber-colored, nearly transparent, rather strongly widening caudad, with brown veins; archet feebly curved; mirror strongly transverse with acute anterior angle (right in *allardi*); seven oblique veins; apical field very short with three veins. Wings not visible beyond the elytra. Subgenital plate narrowing and very feebly notched backwards. Genitalia (fig. 4,o) of the same type as *allardi* but narrower at apex.

Length of body 10.5 mm.; length with wings 12.0 mm.; posterior femur 8.0 mm.; elytra 9.0 mm.; width of elytra 5.0 mm.

*Diatrypa schunkei*, new speciesFIGURE 4,*p*

HOLOTYPE: Male; Pucallpa, Río Ucuyali, Perú, Mar. 9, 1948, Schunke (USNM 62082).

MALE: A little larger than the preceding species. Head small, flattened above, finely pubescent; frontal rostrum a little narrower than the 1st antennal joint, strongly darkened. Face as long as wide, yellowish. Eyes feebly projecting cephalad; ocelli very small. Antennae yellow with small brown rings. Palpi yellowish; 4th joint of maxillary palpi a little shorter than 3d, 5th equaling the 3d, rather strongly widening and obliquely truncated at apex.

Pronotum rather strongly narrowing in front, with convex posterior margin; disk feebly convex, uniformly testaceous, finely pubescent; lateral lobes rather low, with feebly sinuated inferior margin, strongly rounded angles. Genitalia rounded at apex (fig. 4,*p*).

Legs short, of the same color as the body, pubescent. Anterior tibiae feebly dilated, perforated with two rather large, oval foramina. Posterior femora rather thick, without any parallel apical part; tibiae armed with four spines on each margin; superointernal apical spur extending scarcely to the middle of the metatarsus; the latter is rather long, armed above with four external denticles, one internal denticle; apical spurs long, the internal extending nearly to the apex of 3d joint.

Elytra extending fairly beyond the apex of abdomen, narrowing towards the apex; mirror of the same shape as in *allardi*, but not so transverse; six oblique veins, feebly curved, disposed rather regularly along the archet; chords short, parallel, the first united to the mirror by a small vein in the angle; apical field rather long, with five veins and a wide reticulation; lateral field wrapping; space between *Sc* and *R* regularly widening from the base nearly to the apex, crossed by 10 very regularly distant veinlets; *Sc* bearing 11 branches. Wings a little longer than the elytra.

Length of body 14.5 mm.; length with wings 17.5 mm.; posterior femur 8.0 mm.; elytra 12.2 mm.

REMARKS: Very close to *allardi*; larger with less transverse mirror, apical field longer, space between the diagonal vein, the mirror and the first chord a little wider.

*Diatrypa minuta*, new species

HOLOTYPE: Female; Tingo María, Perú, Feb. 19, 1950, Allard (USNM 62083).

FEMALE: Very small for the genus; blackish brown with a white band on the elytral edge. Head as wide as pronotum, brown, flat-

tened and finely shagreened above; frontal rostrum a little wider than half the 1st antennal joint, flat with parallel margins. Face short and wide, brown, shining. Eyes horizontally lengthened; ocelli very small. Antennae rather thick, the six 1st joints blackish brown, the rest yellow with very distant small brown rings. Palpi short, yellowish with apex of each joint feebly darkened; 4th joint of the maxillary palpi shorter than 3d, 5th triangular, slightly longer than wide.

Pronotum as long as wide, with straight anterior margin, very weakly convex posterior margin; disk feebly convex, blackish, smooth; anterior margin narrowly rufous; lateral lobes very long, with straight inferior margin, much-rounded anterior angle. Abdomen brown; subgenital plate narrowing and feebly notched at apex. Ovipositor rather long, straight; apical valves somewhat flattened, wide, truncated at apex and armed with a large tooth on the external angle and two teeth on the apical margin.

Legs rather long, yellowish. Anterior femora presenting on the internal face a somewhat irregular longitudinal brown band; tibiae adorned above with brown, feebly enlarged at base, perforated with two oval tympana, the external being much larger than the internal; metatarsus very short, scarcely longer than the 2d joint. Median legs similar to the anterior ones. Posterior femora strongly dilated at base, rather short; tibiae armed on each margin with four spines scarcely longer than the denticles which are relatively very strong; apical spurs short; metatarsus yellow with brown apex, compressed, armed above with four denticles, apical spurs short and strong.

Elytra a little longer than the abdomen, dark brown with a whitish band along the edge, extending on the extremity; dorsal field with feebly oblique, regularly spaced veins; *R* bearing two branches, *Rs* simple, *M* and two anal veins curled at their extremity; transverse veinlets scarce and rather irregular; lateral field very dark brown; *Sc* with two branches. Wings scarcely exceeding the elytra.

Length of body 9.0 mm.; length with wings 10.0 mm.; posterior femur 6.4 mm.; elytra 6.5 mm.; ovipositor 6.3 mm.

### **Genus *Amblyrhetus* Kirby, 1906**

#### ***Amblyrhetus nodifer*, new species**

FIGURE 5, *a, b*

**TYPES:** Holotype: Male; Chanchamayo, Department of Junin, Perú, elevation 1,200 meters, May 4, 1948, Schunke (USNM 62084). Allotype: Tingo María, Perú, November 1949, Allard (♀) (USNM).

**MALE:** General shape rather short and thick; color uniformly rufous brown; finely pubescent. Head rather small, short; vertex weakly flattened, scarcely sloping; frontal rostrum as wide as 1st antennal joint. Face as long as wide, rufous. Antennae thick, yellowish at

base, becoming brown towards the middle. Palpi rufous brown, short; 4th joint of maxillary palpi shorter than 3d, 5th as long as 3d, feebly enlarged with parallel margins. Eyes feebly projecting; ocelli very small.

Pronotum  $1\frac{1}{2}$  times as wide as long, with feebly concave anterior margin, slightly narrowing in front; disk almost flat, uniformly rufous brown; lateral lobes high, with straight inferior margin, rounded anterior angle, posterior angle completely obliterated. Abdomen dark brown above, rufous beneath; subgenital plate large, narrowing subacute at apex, nonfurrowed. Genitalia in the shape of a rather regular triangular plate (fig. 5,b).

Legs short, of the same color as the body. Anterior and median femora compressed, slightly darkened at apex; anterior tibiae almost prismatic, rather strongly dilated at base, perforated with two large, oval tympana, the external being still larger than the internal; apex of the anterior and median tibiae armed with three very small spurs; metatarsi very short. Posterior femora short, very thick, blackish at top; tibiae furrowed above, armed with five external spines, the two distal ones being very close, four long internal spines; denticles at base and between the spines strong. Metatarsus rather short, thick, armed above with two external denticles, one internal denticle at apex; apical spurs rather short, subequal in length.

Elytra lighter than the body, of a pale testaceous, finely pubescent, extending a little beyond the extremity of the body, feebly enlarged at apex; mirror in the shape of a wide, feebly oblique oval, divided in the middle by a straight vein; archet weak, strongly broken before the angle; anal veins much stronger than the archet; four oblique veins forming two well distant groups; the two internal of these veins are long, united at base by a strong nodosity; the two external ones are short, emerging from the archet in the deep curve before the angle; diagonal vein long, feebly oblique; chords rather long, the second strongly convex, the first united to the mirror by a short vein; apical field rather long, with four veins and a rather regular reticulation; lateral field wrapping; Sc bearing 12 branches. Wings a little longer than the elytra.

FEMALE: Head, pronotum, and legs as in the male. Abdomen blackish above, yellowish mottled with brown beneath; subgenital plate wide, notched at top in a semicircle. Ovipositor short, thick, feebly curved upwards; apical valves flattened, rectangular, truncated at top. Elytra presenting rather regularly spaced oblique veins; four are coming from the *Cu* and one from *Cu.p*; areolae rather regular, pentagonal, disposed in two series between each vein; Sc bearing eight branches.

DIMENSIONS: Length of body, ♂ 14.0 mm., ♀ 15.0 mm.; length with wings, ♂ 17.0 mm., ♀ 19.0 mm.; pronotum, ♂ 3.0 mm., ♀ 3.2

mm.; posterior femur, ♂ 7.6 mm., ♀ 8.2 mm.; elytra, ♂ 12.0 mm., ♀ 14.0 mm.

REMARKS: This species is close to *A. brevipes* Saussure, from Colombia; the male elytron presents four oblique veins instead of the two in *brevipes*, and the archet is strongly angulate, apical field with veins more distant; the ovipositor of the female reminds rather the shape of *capitatus* Saussure.

### Genus *Aphonomorphus* Rehn, 1903

#### *Aphonomorphus telskii* (Saussure)

FIGURE 5,c-e

*Aphonus telskii* Saussure, Mission scientifique au Mexique . . . Recherches zoologiques, pt. 6, section 1 (Orthoptères), p. 511, 1874.

SPECIMENS EXAMINED: BOLIVIA: Tumupasa, December 1921 (1 ♂), Mann.

#### *Aphonomorphus stipatus*, new species

FIGURE 5,f, 6,g

HOLOTYPE: Male; Cavinás, Río Beni, Bolivia, January 1922, Mann (USNM 62085).

Male: Color of a dark testaceous brown with the median vein yellow marked with about 10 small brown spots. Fifth joint of the maxillary palpi securiform, as long as wide. Dorsal field of the elytra presenting a rather regular reticulation; the areolae are long, narrow, disposed on three rows between each vein about the middle of the elytron; towards the apex the areolae are wider; veins rather well marked among the reticulation; their number is six, of which four come from the median vein, the other two from the cubital; *Sc* bearing eight branches. Subgenital plate furrowed in the middle, feebly notched at apex. Anterior and median legs feebly mottled with brown; posterior femora with inferior margin spotted with brown. Genitalia of the same type as *telskii* with longer teeth (fig.5,f).

Length of body 19.5 mm.; length with wings 30.5 mm.; posterior femur 13.0 mm. elytra 21.0 mm.

#### *Aphonomorphus socius*, new species

FIGURE 5,g

HOLOTYPE: Male; Tingo María, Perú, Feb. 10, 1950, Allard (USNM 62086).

Male: Very close to the preceding but coloration darker; space between *Sc-R* and *R-M* blackish, shining; antennae very neatly annulated; top of the forehead blackish; 5th joint of the maxillary palpi a little longer. Areolae of the dorsal field of elytra narrow but less numerous, disposed on two rows only between the veins; these are



very feebly marked. Genitalia quite different, somewhat asymmetrical with long straight points (fig. 5,g).

Length of body 18.5 mm.; length with wings 28.5 mm.; posterior femur 13.5 mm.; elytra 19.5 mm.

*Aphonomorphus dissimilis*, new species

FIGURE 5,h

HOLOTYPE: Male; Reyes, Bolivia, October 1921, Mann (USNM 62087).

MALE: Very light brown, the median vein of elytra very feebly mottled but with a very neat brown spot at base. Posterior margin of pronotum subangulate. Fifth joint of maxillary palpi scarcely longer than wide, securiform with superior margin much longer than the inferior, feebly concave. Sides and inferior face of abdomen light yellow, mottled with brown, the spots confluent on the median line, forming a brown band. Veins of the dorsal field of elytra very weak; reticulation long and narrow. Genitalia strongly asymmetrical, with three very long processes (fig. 5,h).

Length of body 16.5 mm.; length with wings 26.0 mm.; elytra 20.5 mm.

*Aphonomorphus obscurus*, new species

FIGURE 5,i,j

TYPES: Holotype: Male; Cachuela Esperanza, Bolivia, March 1922, Mann (USNM 62088). Allotype: Ixiamas, Bolivia, December 1921, Mann (♀).

MALE: Very dark brown with lighter legs. Head uniformly brown; vertex slightly flattened; ocelli united by a small carina in the shape of a Y. Face also very dark, smooth. Palpi light rufous; 5th joint of maxillary palpi securiform, a little longer than wide, darkened at top, with superior margin feebly concave. Antennae brown with small light rings. Posterior margin of pronotum convex, not at all angulate. Elytra very finely pubescent; dorsal field with very regular venation; veins feebly oblique and scarcely visible on the reticulation; areolae long and narrow; median vein spotted with yellow. Abdomen almost black beneath; subgenital plate long, nonfurrowed. Genitalia of the same type as the preceding, not so strongly asymmetrical (fig. 5,i).

FEMALE: Quite similar to the male but much larger. Ovipositor very long and slender; apical valves very narrow, acute; superior valves finely denticulated, inferior with two large teeth (fig. 5,j).

Length of body 20.0 mm. (approximate, abdomen retracted); length with wings 31.5 mm.; posterior femur 14.0 mm. elytra 23.0 mm.; ovipositor 25.0 mm.

*Aphonomorphus deceptor*, new speciesFIGURE 5,*k*

Types: Holotype: Male; Pucallpa, Río Ucuyali, Perú, Sept. 16, 1947, Schunke (USNM 62089). Paratype: Same locality as holotype (1 ♂) (MNHN).

MALE: Rather large; uniformly light brown; median vein marked with regularly alternate brown and yellow small spots. Face yellow, somewhat spotted with brown; 5th joint of maxillary palpi as long as wide, securiform. Antennae light brown with feebly visible yellow rings. Auditory foramina relatively narrow, the anterior tibiae presenting a long furrow on the internal face. Subgenital plate long, furrowed, notched at apex. Elytral veins difficult to see among the reticulation which is extremely close. Genitalia completely asymmetrical with big, rounded median process (fig. 5,*k*).

Length of body 19.0 mm.; length with wings 30.0 mm.; posterior femur 13.0 mm.; elytra 21.0 mm.

REMARKS: Very close to *A. stipatus* with elytral reticulation still closer; genitalia completely different from all the other species.

Another male from the same locality is quite similar to the type.

*Aphonomorphus schunkei*, new speciesFIGURES 5,*l,m*, 6,*h*

HOLOTYPE: Male; Pucallpa, Río Ucuyali, Perú, Nov. 29, 1947, Allard (USNM 62090).

MALE: Coloration rather light testaceous brown; vertex very feebly darkened; 5th joint of maxillary palpi a little longer than wide, securiform. Antennae light testaceous, very feebly annulated. Elytral venation rather confused; all the veins are concolorous except a few very small brown spots; areolae relatively very large, disposed on one or two rows between the principal veins. Abdomen brown beneath; subgenital plate furrowed. Genitalia presenting a superior bifid bridge and six long processes (fig. 5,*l,m*).

Length of body 18.5 mm.; length with wings 25.5 mm.; posterior femur 11.5 mm.; elytra 16.5 mm.

*Aphonomorphus allardi*, new speciesFIGURE 5,*n*

HOLOTYPE: Male; Tingo María, Perú, December 1949, Allard (USNM 62091).

MALE: Very close to the preceding; of a somewhat darker color, with better marked veins; areolae of the elytra not so wide; 5th joint of the maxillary palpi not longer than wide. Abdomen yellow beneath. Genitalia with a very large superior part, acute at apex (fig. 5,*n*).

Length of body 21.0 mm.; length with wings 27.5 mm.; posterior femur 12.0 mm.; elytra 20.0 mm.

*Aphonomorphus adjunctus*, new species

FIGURE 6, *a-e, i*

Types: Holotype: Male; Pucallpa, Río Ucuyali, Perú, Feb. 3, 1948, Schunke (USNM 62092). Allotype: Chanchamayo, La Merced, Perú, Feb. 4, 1949, Schunke (♀) (USNM).

MALE: Very close to the preceding; median vein very neatly spotted and numerous small brown spots in the angles formed by the veins and the transverse veinlets. Vertex very dark brown; face yellow; abdomen brown beneath. Legs feebly mottled with brown. Lateral field of the elytra much lighter than the superior part. Genitalia quite different from *allardi* but rather close to *schunkei* (fig. 6, *a-d*).

Length of body 20.5 mm.; length with wings 27.0 mm.; posterior femur 11.8 mm.; elytra 20.0 mm.

FEMALE: Larger and a little darker than the male. Ovipositor long, straight, with apical valves narrow, acute, presenting six strong, rounded teeth on the inferior margin; superior valves with two triangular teeth on the internal face (fig. 6, *e*).

Length of body 16.5 mm.; length with wings 29.0 mm.; posterior femur 11.0 mm.; elytra 19.0 mm.; ovipositor 13.0 mm.

*Aphonomorphus elegans*, new species

HOLOTYPE: Female; Tingo María, Perú, December 1949, Allard (USNM 62093).

FEMALE: A long and rather narrow species. Head pale brown with four feebly marked yellow lines on the occiput; very feebly convex above; vertex darkened between the antennae; frontal rostrum narrow, scarcely wider than the 1st antennal joint. Face yellow, as long as wide. Antennae yellow with small brown rings. Palpi yellowish, rather short; 4th joint of maxillary palpi shorter than 3d, 5th very short, wide, triangular, straightly truncated at apex. Eyes projecting, feebly lengthened dorsoventrally; ocelli contiguous, the anterior narrow, oval, the lateral ones rounded.

Pronotum posteriorly a little wider than long, rather strongly narrowing in front; posterior margin subangulate; disk yellowish brown with a few small brown spots near the median line and two larger spots of the same color near the anterior angle; anterior and posterior margins spotted with brown; limit between the disk and the lateral lobes marked by a yellow band; lateral lobes long, of the same color as the disk with a few brown spots. Abdomen yellowish brown; subgenital plate small, feebly notched at apex. Ovipositor rather long, slender, feebly curved; apical valves narrow, the inferior with seven strong teeth.

Legs yellowish brown mottled with brown, pubescent. Anterior tibiae rather strongly dilated at base, presenting a large long internal auditory foramen. Posterior femora very long, feebly swollen, presenting above three or four brown spots; tibiae armed with five external, nine internal spines; denticulations at base and between the spines very weak, scarcely visible among the abundant pubescence; apical spurs as usual in *Aphonomorphus*. Metatarsi short, armed above with two external denticles, one internal denticle, apical spurs very long.

Elytra very long and narrow, light brown with a few small brown spots on the median vein; principal veins strongly oblique, feebly visible in a rather close reticulation, formed of long areolae. Wings extending rather strongly beyond the elytra, mottled with brown.

Length of body 15.0 mm.; length with wings 27.0 mm.; pronotum 3.0 mm.; posterior femur 12.5 mm.; elytra 18.5 mm.; ovipositor 13.5 mm.

REMARKS: This species is remarkable by its slender general shape, its long and narrow posterior femora, and the armature of the posterior tibiae.

### Genus *Podoscirtodes*, new genus

DESCRIPTION: General aspect as in *Aphonomorphus* but somewhat shorter. Anterior tibiae perforated on both faces, the external tympanum oval in shape, the internal one elongate, narrow. Elytral venation similar in both sexes, presenting no mirror in the male; subcostal vein bearing four or five branches. Wings feebly overreaching the elytra.

TYPE OF GENUS: *Podoscirtus americanus* Saussure, 1878.

### Genus *Euaphonus* Hebard, 1928

#### *Euaphonus peruvianus* (Saussure)

FIGURE 6,f,j,k

*Aphonus peruvianus* Saussure, Mission scientifique au Mexique . . . Recherches zoologiques, pt. 6, section 1 (Orthoptères), p. 511, 1874.

SPECIMENS EXAMINED: PERÚ: Chanchamayo, June 6, 1948 (1 ♂), Sept. 12, 1948 (1 ♂), Schunke; Pucallpa, Feb. 10, 1948 (1 ♂), Schunke.

### Genus *Paraphonus* Hebard, 1928

#### *Paraphonus vicinus*, new species

FIGURE 6,l

TYPES: Holotype: Male; Fundo Sinchono, about 40 miles southwest of Pucallpa, Río Ucuyali, Perú, Aug. 24, 1947, Schunke (USNM)

62094). Allotype: Tumupasa, Bolivia, December 1921, Mann (♀) (USNM). Paratype: Chanchamayo, Perú, Apr. 29, 1948, Schunke (1 ♂) (MNHN).

MALE: General aspect of a small *Aphonomorphus*; light brown with half a score blackish spots on the median vein. Head above blackish brown with seven yellow lines; frontal rostrum sloping, canaliculated, narrower at apex than the 1st antennal joint, its margins provided with long hairs. Face yellowish. Eyes projecting; lateral ocelli large, oval, anterior one smaller; they are united by a yellow band extending laterally to the eyes. Antennae yellow with a few small brown rings. Palpi yellowish with a weak brown ring at apex of 3d and 4th joints; 5th joint feebly securiform, as wide at apex as long. Pronotum a little wider in front than long, feebly widening backwards; anterior margin nearly straight, posterior margin sinuated; disk feebly convex, pubescent, light brown with two large yellowish impresses; lateral lobes almost twice as long as high, with inferior margin feebly ascending backwards, anterior angle rounded; color blackish in the superior half, yellowish in the inferior one. Abdomen brownish above, yellowish beneath; epiproct quadrangular; subgenital plate rather large, feebly narrowing backwards with apical margin slightly concave. Cerci yellowish. Genitalia triangular in their general shape, divided in the apical third in three lobes, the median being curved upwards and feebly divided at apex.

Legs rather short, yellowish with a few small brown spots, strongly pubescent. Anterior tibiae without any trace of a tympanum. Posterior femora rather strongly dilated, very feebly striated on the external face. Posterior tibiae armed with four\* external, five internal spines, strongly denticulated at base and between the spines; external apical spurs very short; superointernal spur almost twice as long as the median; metatarsus very short, armed with three external denticles and one internal denticle besides the apical spurs, which are long and equal in length.

Elytra light brown, finely pubescent, with very conspicuous dark spots on the cubital vein; veins feebly oblique and regularly spaced; *Cu* bearing two branches; *Cu.p* divided near the proximal fourth; transverse veinlets numerous and rather regular, a little darker than the principal veins; lateral field a little lighter than the dorsal field; *Sc* bearing three branches. Wings a little longer than the elytra.

Length of body 15.5 mm.; length with wings 21.0 mm.; pronotum 2.5 mm.; posterior femur 11.0 mm.; elytra 14.0 mm.

REMARKS: This species seems close to the type of the genus (*Paraphonus cophus* Hebard) but it is not so robust in its general shape, with wings a little longer; from Hebard's description, it seems that the genitalia are of a quite different shape.

## Superfamily TRIDACTYLOIDEA

## Family RHIPPTERYGIDAE

Genus *Rhippteryx* Newman, 1934

The collection contains several species of this genus which are nearly similar in the general shape and coloration but quite different in the shape of the abdominal extremity of the male. The females are almost impossible to separate.

*Rhippteryx difformipes*, new species

FIGURE 6,m,n

HOLOTYPE: Male; Divisoria, elevation 1,600 meters, about 80 miles southwest of Pucallpa, Perú, 1947, Schunke (USNM 62095).

MALE: Small, of a dull black color. Antennae composed of 10 joints, black; 3d to 6th joints yellowish above, 9th joint almost completely yellow; last joint longer than the preceding, black. Pronotum with lateral margins rather narrowly tinged with yellowish. Metanotum prolonged caudad in a sharp point. The three first abdominal tergites are partly united, presenting a strong, rounded, shining tumefaction; 4th tergite with a  $\lambda$ -shaped projection; 10th tergite prolonged in a plate strongly divided at apex with projecting, rounded angles. Cerci extending a little beyond the plate, cylindrical; process of the paraprocts not so long as the subgenital plate, flattened, a little widening at apex. Subgenital plate narrowing towards the extremity, which is notched with a small, acute, median projection.

Anterior legs black; tibiae strongly compressed with an internal groove in which the tarsus is located. Median femora for the most part yellow with black top; tibiae strongly out of shape, roundly dilated at base, then compressed, twisted with external face furrowed above. Posterior femora black; tibiae yellowish; large apical spurs long and slender; metatarsus a little shorter, compressed, acute at apex.

Elytra dull black; wings very elongate, black on the anterior margin, with iridescent posterior field.

Length of body with wings 7-8 mm.

*Rhippteryx vicinus*, new species

FIGURE 6,o

Types: Holotype: Male; Divisoria, elevation 1,600 meters, about 80 miles southwest of Pucallpa, Perú, 1947, Schunke (USNM 62096). Paratypes: Same data as holotype (3♂♂); Fundo Sinchono, Perú, Aug. 15, 1947, Schunke (1♂) (USNM).

MALE: Very close to the preceding. Differing by the yellow band of the pronotum, which is wider, and chiefly by the shape of the ab-

dominal extremity. Ninth tergite presenting in the middle of the posterior margin a narrow notch, the margins of which are elevated in the shape of a small acute tubercle; process of the 10th tergite rather short, divided into two diverging lobes; apex of the subgenital plate notched, each margin presenting six small teeth, median part dilated in a small projecting plate. Median tibiae of the same shape as in the preceding species but a little longer.

Total length 7.5 mm.

*Rhipipteryx femoratus*, new species

FIGURE 6, *p, q*

TYPES: Holotype: Male; Fundo Sinchono, about 40 miles southwest of Pucallpa, Río Ucuyali, Perú, Aug. 9, 1947, Schunke (USNM 62097). Allotype: Same locality as holotype, Aug. 28, 1947, Schunke (♀) (USNM). Paratypes: Chanchamayo, Perú, Jan. 27, 1949 (1 ♂), Apr. 26, 1948 (1 ♀), Schunke; Fundo Sinchono, about 40 miles southwest of Pucallpa, Río Ucuyali, Perú, Aug. 25, 1947 (1 ♀) Schunke; Pucallpa, Perú, July 31, 1947 (1 ♂), Schunke (USNM).

MALE: Very close to both preceding species in the general shape and coloration. Antennae with joints 2 to 6 presenting above a large yellow spot; last joint almost completely yellow, preceding joint black. Pronotum with rather wide, regular yellow lateral band; disk presenting a small median yellow spot. Anterior femora strongly curved and presenting at apex of the inferointernal margin a large, yellow, rounded lobe, which is feebly denticulated at base. Median femora long and slender, compressed, wholly black; tibiae also long and compressed, of normal shape, furrowed in the middle. Abdomen with 9th tergite presenting in the middle a small rounded notch; epiproct very large, flat, ogive-shaped; 10th tergite presenting only very small lateral processes; process of the paraprocts extending a little farther than the subgenital plate, compressed, somewhat enlarged and rounded at apex. Subgenital plate ending in two small diverging lobes, armed with five or six bristles.

FEMALE: Similar to the male but the anterior femora scarcely enlarged at apex. Subgenital plate subacute.

DIMENSIONS: Total length, ♂ 8.0 mm., ♀ 6.8 mm.

REMARKS: The male of this species is quite different from the preceding species in the shape of the anterior legs.

*Rhipipteryx schunkei*, new species

FIGURE 6, *r*

TYPES: Holotype: Male; Chanchamayo, Perú, elevation 1,200 meters, Apr. 24, 1948, Schunke (USNM 62098). Allotype: Same

locality as holotype, May 1948, Schunke (♀) (USNM).

MALE: Differing from *vicinus* in the shape of the abdominal extremity. Last joint of the antennae black.

FEMALE: Cerci cylindrical; process of the paraprocts as long as the cerci, enlarged, rounded at apex. Subgenital plate short, transverse, with posterior margin straight on the sides, strongly convex, sub-angulate in the middle. Ovipositor with curved, strongly acute valves, the inferior ones with a strong basal tooth.

DIMENSIONS: Total length, ♂ 7.2 mm., ♀ 7.0 mm.

## Family TRIDACTYLIDAE

### Genus *Tridactylus* Olivier, 1789

#### *Tridactylus australis* Bruner

*Tridactylus australis* Bruner, Ann. Carnegie Mus., vol. 10, p. 357, 1916.

SPECIMENS EXAMINED: PERÚ: Pucallpa, Río Ucuyali, Oct. 8, 1947 (2♂♂, 2♀♀), Mar. 2, 1948 (1♂), Schunke.

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## THE NEARCTIC SPECIES OF TRIGONALID WASPS

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By HENRY TOWNES <sup>1</sup>

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The Trigonalidae is a small family of Hymenoptera, of which only four species belonging to four genera are known in the Nearctic Region. All of them are parasites, usually secondary parasites, and their hosts include Vespidae, Pergidae, and dipterous and hymenopterous parasites of caterpillars.

Adult trigonalids look somewhat like medium-sized sawflies or wasps. The relationships of the family appear to be with the Aculeata and it fits best in the Chrysidoidea (including the Bethyloidea), but it is aberrant wherever placed and the natural relationships of the families of Apocrita will have to receive a general study before the proper position of this family can be stated with confidence. Characters by which trigonalids may be distinguished from other families of Apocrita are: Flagellum with 14 to more than 20 segments; costal cell of forewing present; hindwing with distinct venation and two closed cells; anal lobe represented by a small vestige; and legs usually with two but sometimes with one trochanter each. Figure 1,*a* illustrates a typical member of the family.

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Trigonalids have a peculiar life history which has been reviewed for several species by Clausen (Entomophagous insects, pp. 56-61, 1940). Their minute and very numerous eggs are laid at random on foliage and subsequently eaten by caterpillars or sawfly larvae. In the case of the species which are secondary parasites of caterpillars, the eggs hatch in the gut of the caterpillar and the trigonalid larva enters the body of the caterpillar to attack an ichneumonid, larvae-vorid, or other parasitic larva. Those species parasitizing social Vespidae presumably find their host when caterpillar prey containing trigonalid larvae are brought to the nest as food for the young. Individuals of the various species tend to vary considerably in size, an indication that they have a wide range of hosts. The species *Lycogaster pullata* has been reared as a parasite both of *Enicospilus americanus* (Ichneumonidae) and of *Rygius rugosus* (Vespidae), indicating an exceptionally versatile host adaptability.

Most of the specimens studied are in the U. S. National Museum (USNM). The locations of specimens in other institutional collections are indicated (in parentheses) by the name of the city in which they are stored.

### Key to the Nearctic genera of Trigonalidae

1. Postscutellum roughly pyramidal, the apex bifid; legs of female each with a single trochanter . . . . . **4. Bareogonales**  
 Postscutellum not pyramidal, of normal shape, not elevated; legs of female each with two trochanters . . . . . **2**
2. Propodeal foramen bounded dorsally by a carina or ridge that is evenly curved; second tergite not punctate; second sternite of female without a tooth.  
**1. Orthogonalys**  
 Propodeal foramen bounded dorsally by a carina or ridge that is sharply angled medially; second tergite punctate; second sternite of female with a strong median apical tooth . . . . . **3**
3. Antenna slender, the median segments about 2.0 as long as wide; male antenna with tyloids; occipital carina not joining the hypostomal carina, reaching the mandible; third sternite of male simple . . . . . **2. Poccilogonales**  
 Antenna thick, the median segments about 1.6 as wide as long; male antenna without tyloids; occipital carina joining the hypostomal carina; third sternite of male with a strong transverse groove . . . . . **3. Lycogaster**

### Genus *Orthogonalys* Schulz

*Orthogonalys* Schulz, Hymenopteren-Studien . . . p. 76, 1905. Type: *Orthogonalys boliviana* Schulz. Monobasic.

*Orthogonalys* Schulz, in Wytsman, Genera insectorum, fasc. 61, p. 8, 1907. Emendation.

*Tapinogonales* Schulz, in Wytsman, Genera insectorum, fasc. 61, p. 14, 1907. Type: *Trygonalys pulchellus* Cresson. Designated by Viereck, 1914.

Noteworthy generic characters in addition to those in the key are: Flagellum long and slender, in the male without tyloids; abdomen smooth, impunctate; apical margin of second to fifth tergites often

with a broad weak median notch; frons only weakly elevated next to the upper inner margin of the antennal foramen.

There is a single Nearctic species, which is moderately common in the Eastern States.

*Orthogonalys pulchella* (Cresson)

*Trigonalys pulchellus* Cresson, Proc. Ent. Soc. Philadelphia, vol. 6, p. 351, 1867.

Type: Male, West Virginia (lost).

*Tapinogonalos pulchella* Schulz, in Wytzman, Genera insectorum, fasc. 61, pl. 2, figs. 56–58 (colored), 1907.

**MALE:** Forewing about 8 mm. long. Colored with black, pale yellow, and fulvous, to mimic the *Taxonus pallidicornis*—*Cratichneumon signatipes* type of coloration. Head and mouthparts yellow, the occiput, vertex, and median part of frons black; vertex with a pair of yellow spots behind the ocelli; antenna black, its scape yellowish beneath and brownish above, its flagellum with a broad whitish post-median band; thorax blackish above with conspicuous yellow markings, yellowish laterally with black bands along the sutures separating off the yellow areas, mostly yellowish below, the mesosternum mostly fulvous; wings hyaline; legs fulvous, the trochanters and much of the coxae pale yellow; abdomen fulvous with a pair of fuscous areas basally on the second tergite and often similar areas or transverse subbasal fuscous bands on several of the following tergites.

**FEMALE:** Forewing about 8.5 mm. long. Colored like the male but with the yellow markings tending to be paler, almost white, the fuscous markings on the abdomen tending to be more as crossbands, and each of abdominal tergites 1 to 5 usually with a lateral white blotch.

**SPECIMENS:** 27 ♂♂, 39 ♀♀ from: District of Columbia; New Jersey (Moorestown); Maine (Paris); Maryland (Bowie, Cabin John, Glen Echo, Lock Raven, Takoma Park, and Plummers Island); Massachusetts (Chester); New York (Farmingdale, Ithaca, Ludlowville, Niagara Falls, and Taughannock); Pennsylvania (Enola and Highspire); Rhode Island (Westerly); and Virginia (Alexandria, Dead Run, Falls Church, Great Falls, and Rosslyn).

Males occur mostly in June and early July, their earliest and latest dates of capture being May 25 at Plummers Island, Md., and July 21 at Ithaca, N. Y. Females occur mostly from mid-June to mid-August. Their extreme dates are June 7 at Plummers Island, Md., and Aug. 23 at Niagara Falls, N. Y. This seasonal distribution indicates a single generation per year. There is a rearing record by Bischoff (Berliner Ent. Zeitschr., vol. 54, p. 76, 1909) from *Zenillia lobeliae* (Larvaevoridae), which was parasitic on *Acrionicta lobeliae* (Noctuidae).

Females have been seen ovipositing on several occasions. Notes made on June 20, 1942, at Takoma Park, Md., are as follows: Two females were seen ovipositing in midafternoon. They were in rank undergrowth of damp woods, about 40 cm. above the ground. They ran over the leaves in the manner of a *Macrophya*, about every four seconds going quickly to the edge of a leaf and curling the abdomen over the edge to oviposit on the undersurface near the edge. This oviposition movement was very quick, being completed within a second. The eggs were distributed at random, one or more to a leaf. One female was ovipositing on *Viburnum acerifolium* and the other on a composite similar to *Sericocarpus*. On June 21 a third female was caught and confined in a jar with fresh leaves of *Liquidambar*. On June 23 it was dead. Examination of the leaves showed 8 to 10 extremely minute, elongate-oval eggs, presumably laid by this female, loosely attached to the leaves about 2 mm. from the edges.

REMARKS: This is a species of the Transitional Zone of the Eastern States. Adults are moderately common from early summer to mid-summer in damp rich woodlands, where they occur on the foliage at about the 35-centimeter level. They crawl over the foliage or take short flights. In size, coloration, and movements they mimic several of the species of sawflies and ichneumonids that are common in the same habitat.

### Genus *Lycogaster* Shuckard

*Lycogaster* Shuckard, The Entomologist, vol. 1, p. 123, 1841. Type: *Lycogaster pullata* Shuckard. Monobasic.

There is a single Nearctic species, which is divisible into two subspecies.

#### *Lycogaster pullata* Shuckard

Forewing of male about 6 mm. long, of female about 9 mm. long.

This species is trancontinental in the Transition Zone. Fragmentary evidence indicates that it occurs in more open and dry habitats than the other Nearctic trigonalids. It is represented by an eastern and a western subspecies, as indicated below.

#### Key to the subspecies of *Lycogaster pullata*

1. Tibiae black, the middle tibia white basally and the front and hind tibiae white basally and externally; abdomen black, often with some white marks; range: Atlantic Coast west to 100th meridian.

##### (a) *pullata pullata* Shuckard

Tibiae pale yellow, the hind tibia often infuscate apically on the posterior side; abdomen black with broad pale yellow bands; range: Nevada, Colorado, North Dakota, and New Mexico . . . (b) *pullata nevadensis* (Cresson)



(a) *Lycogaster pullata pullata* Shuckard

*Lycogaster pullatus* Shuckard, The Entomologist, vol. 1, p. 124, 1841. Type: Female, North Carolina (destroyed).

*Lycogaster pullatus* var. *hollensis* Melander and Brues, 1902. Biol. Bull., vol. 3, p. 36, 1902. Types: Male and female, Woods Hole, Mass. (location unknown).

*Lycogaster pullata* Bischoff, Berliner Ent. Zeitschr., vol. 54, pp. 76-77, 1909. Biology.

*Lycogaster pullata* Schulz, Zool. Ann., Wurzburg, vol. 4, pp. 7-8, 1911. Biology.

*Lycogaster pullata* Cooper, Proc. Ent. Soc. Washington, vol. 56, pp. 280-288, 1954. Biology.

MALE: Black. Bases of tibiae, anteroexternal face of front tibia and usually also of hind tibia, most of basitarsi except apices, hind corner of pronotum, and usually lateroapical blotch on some or all of tergites 2 to 5 white; tegula brown; wings hyaline, their apical 0.4 faintly infuscate.

FEMALE: Colored like the male except that the white markings average a little more extensive. The specimen from Bottineau, N. Dak., noted below, has coloration intermediate to the subspecies *nevadensis*.

SPECIMENS: 5 ♂♂, 20 ♀♀ from: District of Columbia; Maryland (Glen Echo); Massachusetts; Michigan (Midland County, Missaukee County, and Roscommon County); New York (Ithaca); North Carolina (valley of the Black Mountains); North Dakota (Bottineau); Rhode Island (Westerly); Vermont (Fairlee); and Virginia (Falls Church, Glencarlyn, and Upton).

Dates of collection fall in June and July except for two collections in May and one in August (May 9 at Glencarlyn, Va.; May 19 in the District of Columbia; and August 25 at Bottineau, N. Dak.).

One specimen bears the note that it was collected on *Solidago* and another on *Ceanothus*. A male specimen in the U. S. National Museum that was taken from a cocoon of *Telea polyphemus* in June 1944 by C. Brooke Worth has some manuscript notes associated with it which are of unusual interest. Mr. Worth states that the cocoon was collected at Washington, D. C., during the winter of 1944. Since it had not hatched and was very light, the cocoon was opened June 13, 1944. The trigonalid was within the *polyphemus* cocoon, which also contained a perforated parasite cocoon, presumably that of *Enicospilus americanus* (Ichneumonidae). The ichneumonid cocoon contained some liquid and semiliquid material among which could be identified the apparent remains of an ichneumonid larva and its meconium. The trigonalid was between the walls of the moth cocoon and the ichneumonid cocoon, alive and active. Schulz (1911) reports rearing this species from a cocoon of *Enicospilus americanus* within a cocoon of *Telea polyphemus*, a situation similar to that noted

by Mr. Worth. Also, Bischoff (1909) reports a rearing from *Enicospilus americanus* parasitizing *Telea polyphemus*. Cooper (1954) describes in detail a case of parasitism of *Rygius rugosus* (Vespidae). J. C. Bridwell has informed me in conversation that he has seen the species ovipositing on oak sprouts in the vicinity of Washington, D. C.

(b) *Lycogaster pullata nevadensis* (Cresson), new status

*Trigonalys nevadensis* Cresson, Proc. Ent. Soc. Acad. Nat. Sci. Philadelphia, p. vii, in Trans. Amer. Ent. Soc., vol. 7, 1879. Male and female. Type: Female, Nevada (Philadelphia).

*Lycogaster nevadensis* Schulz, in Wytzman, Genera insectorum, fasc. 61, pl. 2, figs. 32-37 (colored), 1907.

MALE: Black. Hind corner of pronotum, much of tegula, a bilobed spot on scutellum, apices of femora, tibiae, broad apical margins of tergites 1 to 4, broad apical margin or lateroapical triangle on sternite 1, and lateroapical corners of sternites 2 to 4 pale yellow; tarsi pale yellow, brownish apically; wings yellowish hyaline, their apical 0.4 faintly brownish; hind tibia sometimes with a brown apical mark on the posterior side.

FEMALE: Colored like the male except that the yellow marks on the abdominal terga average a little broader, the hind tibia more frequently has the brown apical mark, and the lower front corner of the pronotum is narrowly marked with yellowish.

SPECIMENS: Male, bred from *Hyphantria cunea* (probably as a secondary parasite), Boulder, Colo., Sept. 29, 1937, R. B. Swain (USNM); 3 ♂♂, 6 ♀♀, bred from *Hyphantria cunea* (probably as a secondary parasite), Boulder, Colo., Oct. 17, 1937, R. B. Swain (USNM); ♀, Colorado, C. F. Baker collection (USNM); ♂, Jemez Springs at 6,400 ft., N. Mex., June 24, 1916, John Woodgate (Ithaca); ♀, Corvallis, Oreg., Apr. 28, 1941, H. A. Scullen (Corvallis); ♂, Martin, S. Dak., June 16, 1925, H. C. Severin (Cambridge).

**Genus *Poecilogonalos* Schulz**

*Poecilogonalos* Schulz, in Wytzman, Genera insectorum, fasc. 61, p. 9, 1907.

Type: (*Trigonalys pulchella* Westwood) = *thwaitesii* Westwood. Monobasic.

This is a rather large and widely distributed genus, but with only a single representative in the United States.

***Poecilogonalos costalis* (Cresson)**

FIGURE 1

*Trigonalys (Lycogaster) costalis* Cresson, Proc. Ent. Soc. Philadelphia, vol. 6, p. 352, 1867. Type: Male, Massachusetts (Philadelphia).

*Trigonalys sulcatus* Davis, 1898. Trans. Amer. Ent. Soc., vol. 24, p. 349, 1898. Type: Male, Angelsea, N. J. (Philadelphia).

MALE: Forewing about 7 mm. long. Black. Front orbit, part of hind orbit, clypeus except apical margin and usually a median area, a spot above antennal socket, front face of mandible, anterior part, upper edge, and hind corner of pronotum, a line inside of notaulus, a narrow line on mesoscutum next the forewing, a mark on upper part of mesopleurum, a pair of large spots on scutellum, most of postscutellum, a pair of spots on propodeum, a yellow apical band on second tergite, narrower apical bands on most of the other tergites, large lateral apical dashes on second sternite, usually similar but smaller marks on some of the other sternites, and most of legs yellow; coxae, except apically, blackish; femora behind and often above brown; hind tibia apically brownish; flagellum tinged with fulvous beneath; wings hyaline, the front wing brown anteriorly, darkest in the radial cell.

FEMALE: Forewing about 7.5 mm. long. Colored similar to the male but with the yellow marks a little more extensive. The apical tooth on the second sternite is deeply notched.

SPECIMENS: 22 ♂♂, 28 ♀♀ from Maryland (Cabin John, Plummers Island, and Takoma Park); Massachusetts (Falmouth); New York (Huntington, Ithaca, Taughanick, West Point, and Woodlands); North Carolina (Burnsville, Hamrick, Southern Pines, and valley of the Black Mountains); Ohio (Ross County and Scioto County); Pennsylvania (Castle Rock, Dauphin, Glenside, and Mount Holly Springs); South Carolina (Greenville); Virginia (Arlington, East Falls Church, Falls Church, Glencarlyn, Great Falls, Mount Vernon, Rosslyn, and Vienna); and West Virginia (Kanawha Station).

Collection dates are mostly from June 25 through August 4, with no apparent trend towards protandry. Dates outside of this range are: June 10 in Scioto County, Ohio; June 15 at Plummers Island, Md.; August 19 at Hamrick, N. C.; August 30 and September 6 at Falls Church, Va.; and October 31 at Southern Pines, N. C. One male and two females were reared from *Phosphila turbulenta* (Noctuidae), probably as a secondary parasite, at Falmouth, Mass., June 30, 1928, and July 11, 1928. One male was collected at honeydew on *Liriodendron*.

REMARKS: This species is seen in semishade of rich woods with abundant undergrowth, at the 20- to 40-centimeter level. In general appearance it resembles a robust sphecoid wasp but may be distinguished in life by its slender, fast vibrating antennae. The oviposition habits are generally similar to those described for *Orthogonalys pulchella*, but the females move more quickly and seem to scatter their eggs more widely. They take a little longer to place each egg and appear as if inserting them through the lower epidermis into the leaf tissue. In this action the heavy tooth on the apex of the second sternite appears to hold the upper edge of the leaf while the apex of

the abdomen curls under and implants the egg with pressure against the tooth on the upper side of the leaf. In general, the species is widely distributed in the Transition Zone of the Eastern States. It occurs mostly in midsummer, in partially sunlit openings of rich woods.

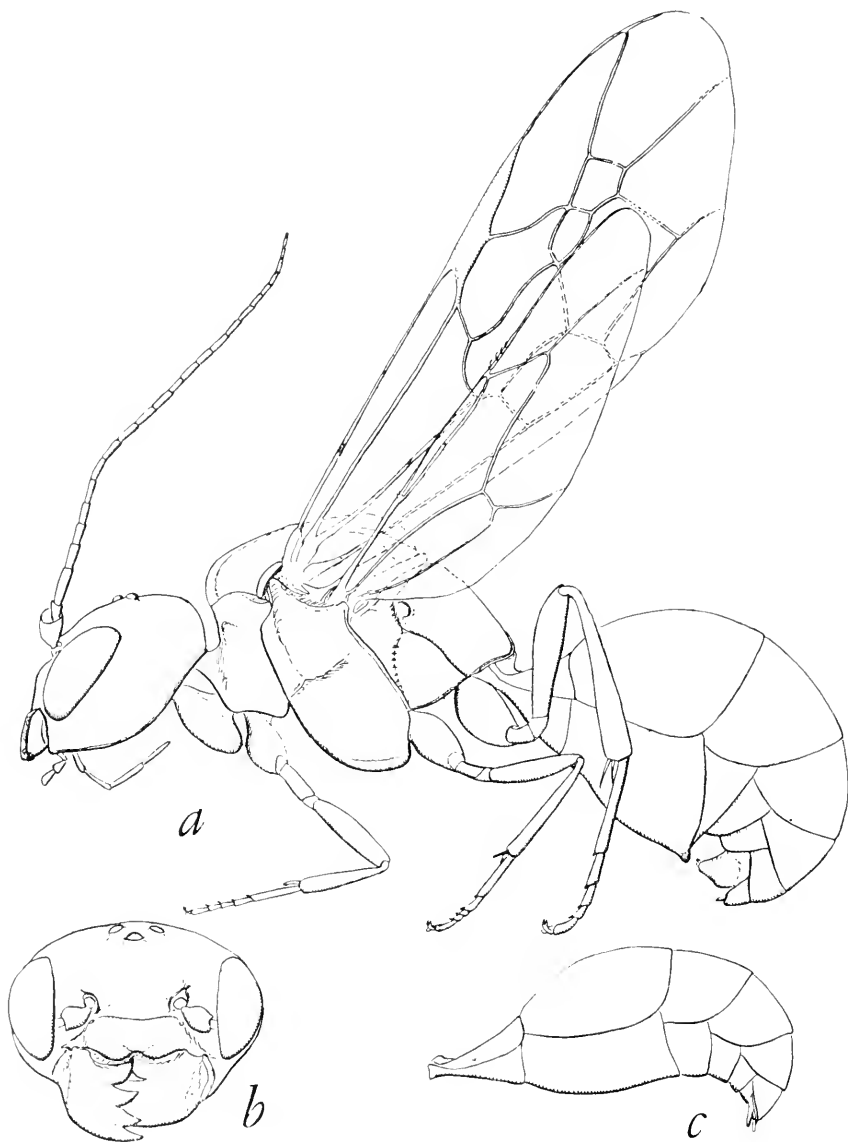


FIGURE 1.—*Poecilognathos costalis*: *a*, female, side view; *b*, head, facing view; *c*, abdomen of male, side view.

**Genus *Bareogonalos* Schulz**

*Bareogonalos* Schulz, In Wytsman, Genera insectorum, fasc. 61, p. 18, 1907.

Type: *Trigonalys canadensis* Harrington. Monobasic.

*Nippogonalos* Uchida, Ins. Mats., Sapporo, vol. 3, p. 79, 1929. Type: *Nippogonalos jezoensis* Uchida. Original designation.

This genus is easily distinguished by its pyramidal postscutellum, bifid apically, and the 1-segmented trochanters of the female. The members of the genus are larger and more robust than the average trigonalid. *Vespa* and *Vespula* have been recorded as hosts.

Through the generosity of Prof. T. Uchida I have been able to compare specimens of the Japanese species *B. jezoensis* with the American *B. canadensis*. They are rather closely related. The Japanese species has the scutellar elevation lower, thoracic sculpture a little coarser, and the coloration of the forewing different. In *jezoensis* the forewing is subhyaline with the apical 0.4 lightly infusate; in *canadensis* the forewing is yellowish hyaline with the radial cell rather strongly infusate and the apical margin faintly, broadly infusate.

***Bareogonalos canadensis* (Harrington)**

*Trigonalys canadensis* Harrington, Canadian Ent., vol. 28, p. 108, 1896. Female misdetermined as male. Type: Female, Victoria, B. C. (lost).

*Trigonalys canadensis* Taylor, Canadian Ent., vol. 30, pp. 14-15, 1898. Biology.

*Trigonalys canadensis* Harrington, Canadian Ent., vol. 30, pp. 14-15, 1898.

Description of male.

*Bareogonalos canadensis* Schulz, in Wytsman, Genera insectorum, fasc. 61, pl. 3, figs. 82-90 (colored), 1907.

MALE: Forewing about 8.5 mm. long. Black. Hind corner of pronotum, postscutellum, lateral spot on propodeum, small marks on coxae, trochanters, bases and apices of femora, tibiae, tarsi and lateral triangular spots on tergites 2-6 (diminishing in size posteriorly) yellow; apical part of hind tibia tinged with brown; wings subhyaline, the radial cell and adjacent areas somewhat infusate.

FEMALE: Forewing about 11.5 mm. long. Colored like the male but with the yellow marks more extensive, the marks on tergites 2-6 broadened and fused into conspicuous transverse yellow bands, sternites 1 and 2 with yellow marks, scutellum mostly yellow, mesoscutum anteriorly with a yellow spot just inside the notaulus, a yellow spot just forward and laterad of the scutellum and of the postscutellum, and a small yellow spot on the mesopleurum.

SPECIMENS: ♂, ♀, British Columbia, October 21 and 25, 1897 (Townes); ♂, British Columbia Biological Station, Departure Bay, British Columbia, Oct. 24, 1908 (Ottawa). In addition to these

three. I have had the opportunity to study briefly a number of specimens at Ottawa. These showed considerable variation in the extent of the yellow markings.

Harrington's type was taken from the cell of a wasp (probably *Vespula*) and Taylor records collecting 23 ♂♂ and 4 ♀♀ near nests of *Vespula pensylvanica*.







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## LATHETICOMYIA, A NEW GENUS OF ACALYPTRATE FLIES OF UNCERTAIN FAMILY RELATIONSHIP

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By MARSHALL R. WHEELER <sup>1</sup>

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The new genus *Latheticomyia*, based upon three new species from the mountains of Arizona, Utah, and Nicaragua, presents such an unusual array of characters that its family relationship is quite obscure. At first glance the flies give one the impression of an aberrant *Trigonometopus*, but more careful study suggests the Clusioididae (Clusiidae) or, perhaps, the Anthomyzidae. However, *Latheticomyia* differs from each of those families in many features that are generally considered critical in family distinctions. For the present it seems best to leave the matter of family relationship in abeyance, but I believe it will ultimately prove necessary to erect a new family for this genus.

*Latheticomyia tricolor* and *L. lineata* were taken in the summer of 1951 at banana-baited trap cans set out to attract *Drosophila*, and all specimens were captured during late twilight. *L. infumata* is known from three specimens taken by William B. Heed in June 1954 while making collections of Drosophilidae in Nicaragua. The species are evidently quite rare; in all, we have just 17 specimens of the genus, and I have seen no specimens other than those taken by Mr. Heed and myself.

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*Latheticomyia*, new genus<sup>2</sup>

TYPE SPECIES: *Latheticomyia tricolor*, new species.

Rather slender, medium-sized flies (2.5–4.0 mm.), mostly black with prominent yellow areas on head, mesonotum, scutellum, pleura, and legs.

HEAD: Postvertical bristles convergent, cruciate in *infumata*, less strongly converging in *tricolor* and *lineata*; inner and outer verticals strong, normal in position; occiput flat or a bit concave; ocelli on a small raised prominence, the ocellar bristles strong, proclinate and divergent, their bases within the ocellar triangle; front longitudinally depressed to sunken between the orbits, becoming deeper anteriorly; each orbit with three reclinate orbitals, the anterior one close to antennal base; orbits, between antennae and anterior orbitals, rather thickly haired; mesofrons with small hairs, no bristles.

Antennae somewhat porrect, both basal segments with evident hairs; arista weakly pubescent, inserted dorsally and subapically; face flat and retreating in profile, sunken in the middle, without foveae, and bearing small fine hairs on the upper part between antennae (see species descriptions for quantity and color); one pair of moderately strong vibrissae, the following oral hairs mostly small, the row ending with a prominent buccal bristle; palpi of normal size and shape.

THORAX: Five pairs of dorsocentral bristles of which three are clearly postsutural, one pair is at about the sutural level, and one pair is clearly presutural; prescutellar acrostichal bristles small or absent; acrostichal hairs present; scutellum small and flat, with small scattered hairs on the sides and the disc sparsely haired or bare; six large marginal scutellar bristles, the apical pair largest and cruciate or nearly so. Other bristles are present as follows: 1 propleural (borne on the apex of a short peduncle), 1 humeral, 2 notopleural, 1 presutural (=posthumeral), 2 alar (apparently 1 supra-alar and 1 post-alar), 2 sternopleural; the mesopleura entirely bare.

LEGS: First femur with moderately stout bristles; third femur with a single enlarged bristle at about one-fourth from apex (strongest on *tricolor*); tibiae without evident preapicals, a moderately strong apical on 2d tibia, a weaker one on 3d tibia. In males of *tricolor* the first metatarsus bears an apical thumblike projection on its inner side, absent on females.

WINGS: Venation of the general acalyptrate type; costa reaching 4th vein; costa broken or weakened just beyond humeral crossvein (not always easily seen), and a definite costal incision just before apex of first vein; subcostal (auxiliary) vein strong basally, weaker

<sup>2</sup> *Latheticomyia*: constructed from the Greek *latheticos* (addicted to concealment, that easily conceals itself) + *myia* (a fly); the name is feminine.

apically, bending toward and fusing with the first vein before its apex, the latter somewhat thickened at its union with the costa. Anal cell well developed, the anal vein ceasing abruptly before reaching the wing margin; last section of fifth vein usually failing to reach wing margin, its length a little more than half that of the posterior cross-vein. A crossvein between the 2d basal and discal cells absent or only partially indicated as a stub. Wings clear hyaline in *tricolor* and *lineata*, blackish in *infumata*.

ABDOMEN: Male genitalia large and complex, bent back beneath abdomen (see figures). Female abdomen long and slender, tapering at apex but not clearly telescoped.

REMARKS: The immature stages, food, breeding habits, etc., are unknown.

*Latheticomyia tricolor*, new species

FIGURES 1,*a-c*; 2,*a,b*

Figure 1,*a* shows the general appearance of the male, without color pattern, while figures 2,*a,b* represent the color patterns seen from the side and from above.

MALE: Face and cheeks pale yellowish white, proboscis, palpi, and clypeus yellow; face with a median furrow from antennae to clypeus, bounded by a semiprominent ridge on each side, with smaller depressed areas lateral to these; upper face, below and between antennal bases, with 0-2 small dark hairs and a few pale ones. Antennae mostly brown on outer side, but yellow on lower apical edge and mostly yellow on the inside except on upper margin and at apex; both inner and outer margins of 2d segment rounded, not pointed; 3d antennal segment subquadrate in shape, thickly covered with fine hair.

Anterior orbital two-thirds length of second and one-half length of third, the latter reclinate and inclined a bit outwardly, the other two only weakly reclinate; orbits pale yellow behind middle orbital and usually without additional hairs, becoming dark brown anteriorly, this area with numerous short, black hairs. The divergent ocellars, convergent postverticals, and divergent outer verticals about as long as middle orbital; inner verticals longer.

Mesonotal dark area (fig. 2,*a*) with thin gray pollen, especially between dorsocentral rows; pale area of scutellum yellow. Of the five pairs of dorsocentrals, the last pair is the largest; no prescutellars; acrostichal hairs irregular, 2-rowed posteriorly, becoming more numerous anteriorly. Scutellar disc with sparse scattered hairs, mostly limited to the dark areas. Humeral callus pronounced, bearing 4-5 black hairs in addition to the single upturned bristle; propleural bristle upturned, arising from a small protruding knob.

Color of legs as in figure 2,*b* but the contrast between light and dark areas (yellow and brownish black) is not always as great as shown. Tarsi of first legs somewhat thickened; first metatarsus with black, long hairs below basally, the joint continued apically as a thumblike flap over the base of the next joint; metatarsal length only a little less than the length of the remaining segments combined.

Abdomen mostly pollinose black, the tergites showing creamy yellow apices, especially the pregenital tergite; all tergites yellow on the extreme lateral margins. There appear to be five pregenital tergites: the first is rather elongate (possibly a fusion of two tergites), the next three are narrower, and the fifth is again larger. The genitalia (fig. 1,*a-c*) nearly equal the rest of the abdomen in size; tergites 6 and 7 (apparently) form the apex of the abdomen, the seventh bent back beneath to nearly the third coxae; the sixth rather shiny black, main portion of seventh dirty yellow, while the apex is darkened again. The single accessory organ (see fig. 1,*a*) is an elongate flap, thin, shallowly concaved along its entire length, the margins and underside bearing numerous, slender, pale to brownish hairs, those of each side near base stouter and longer; this unpaired accessory structure seems to be attached ventrally beneath the fourth and fifth tergites.

The abdomen of one paratype male (deposited in the U. S. National Museum) was removed, treated with sodium hydroxide, cleared in phenol, and studied in glycerine; after the drawings were prepared the genitalia were placed in a drop of glycerine in a microvial and this was attached to the pin bearing the specimen. Figure 1,*b* shows the external features of the genital segments; the anal plates are densely haired; just anterior to the anal plates, middorsally, is a depressed area (shown in the figure by stippling); the approximate position of tergite 5 is shown in dotted outline.

In figure 1,*c* are shown most of the internal structures visible in the cleared specimen; parts labeled B and C (ejaculatory apodeme?) are unpaired, B being quite dark in color. Part A (apodeme of the penis?) is bifurcate at the point indicated by the label line into a right and left branch (only one branch is shown), each of which bears the two processes shown in the figure.

Wings clear, the venation generally as in figure 1,*a*; on the costal base, dorsally, arises a rather long bristle reaching well beyond the humeral crossvein; ventrally, a smaller bristle arises nearly opposite the large one.

Body length (in pinned specimen), 2.5-3.0 mm.; wing, about 2.5 mm.

**FEMALE:** With the general appearance of the male but the abdomen is longer and more slender. First tergite long, second much shorter, with the following three consecutively larger; sixth tergite elongate,

tapering to its apex. There are no visible cerci protruding. The front metatarsus of the female lacks the thumblike extension of the male, and the upper facial hairs tend to be more numerous (usually 8–10 in number) though many of them are pale and hard to see. The body length is up to 4.0 mm. in a specimen with the abdomen extended.

**Types:** Holotype male, USNM 62897, Rustler Park Campground, Chiricahua Mountains, Coronado National Forest, Ariz., June 11, 1951. Paratypes as follows: 2 males, 1 female, from the type locality;

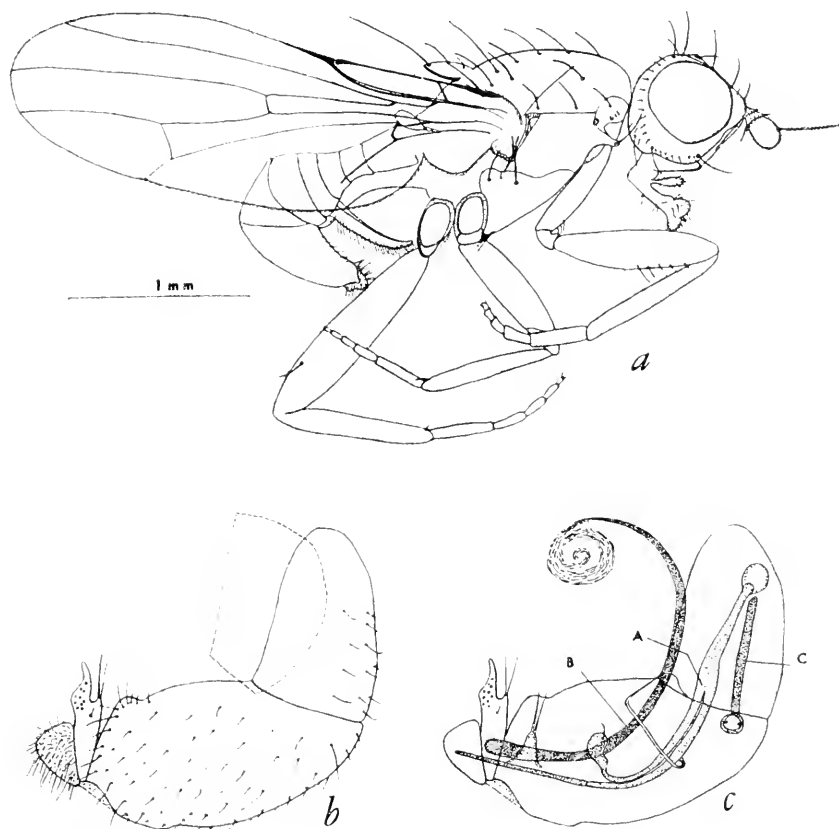


FIGURE 1.—*Latheticomyia tricolor*: a, holotype male, lateral view; b, male genital segments, external features; c, same, internal structures drawn from cleared specimen.

2 males, Mingus Mountain Recreation Area, Prescott National Forest, Ariz., June 20, 1951; 1 female, Ramsey Canyon, Huachuca Mountains, Ariz., June 15, 1951; 1 female, Horse Thief Basin Recreation Area, Prescott National Forest, Ariz., June 18, 1951; 1 female, Clover Springs, near Long Valley, Coconino National Forest, Ariz., June 22, 1951; 1 male, near Long Valley Junction, Dixie National Forest, Utah, Aug. 18, 1953 (W. B. Heed, collector). Two paratypes

are being placed in the U. S. National Museum collection and one each in the collections of A. H. Sturtevant and George Steyskal; the remainder are in the author's collection.

*Latheticomyia lineata*, new species

FIGURE 2,c,d

**MALE AND FEMALE:** Face tan in middle, whitish on facial orbits, cheeks whitish becoming tan behind and below, that portion below the row of oral hairs tan to brown and conspicuously shining; vibrissa single, thin, followed by an irregular row of 8-10 hairs ending with the buccal bristle; tiny hairs of upper face scarcely visible on the only male due to a partial collapse of the head, but on the females there are 10-15 black hairs, easily visible. Clypeus tan to brown, narrow; palpi tan with coarse black hairs; proboscis pale.

Front with color pattern as in figure 2,c; orbits whitish yellow to just beyond middle orbital, this yellow area continuing broadly onto rear of head on each side; dark part of front burnt brown in color with the postlunular area more orange and beset with small scattered hairs. Antennae mostly brown, becoming pale yellowish only on lower inner surface; arista dark, microscopically pubescent. Anterior orbital bristle about two-thirds the length of the other two.

The color pattern of the mesonotum is shown in figure 2,c, but in general the contrast between light and dark areas is not so striking as in *tricolor* and *infumata*; similarly, in figure 2,d, the contrast of colors on the legs is not as extreme as shown. The dark areas of the mesonotum are brownish with thin pollinosity, with the median yellow area continued anteriorly along the dorsocentral lines to a varying degree, only rarely reaching the humeral yellow area. The pale streak between the alar and dorsocentral bristles may also be largely obliterated.

Scutellum mostly yellow, the brown being limited to the basal angles; disc with scattered black hairs; basal scutellars two-thirds the length of second pair, the latter about one-third the length of the apical pair. Acrostichal hairs irregularly 4-6 rowed at the sutural level, reduced to two rows on the yellow area posteriorly, the pre-scutellar pair only a little enlarged. Prescutellar dorsocentrals noticeably larger than the four anterior ones. Halteres yellow.

Abdominal tergites dark brown with their apical margins creamy yellow. In the only male the genitalia are obscured by the legs but appear to be of the same general type as in *tricolor*.

Body length of female (abdomen extended), 3.5 mm.; wing, 2.8 mm.

**TYPES:** Holotype female, USNM 62898, Horse Thief Basin Recreation Area, Prescott National Forest, about 25 miles south (airline) of Prescott, Ariz., June 18, 1951. Paratypes as follows: 1 female, Oak

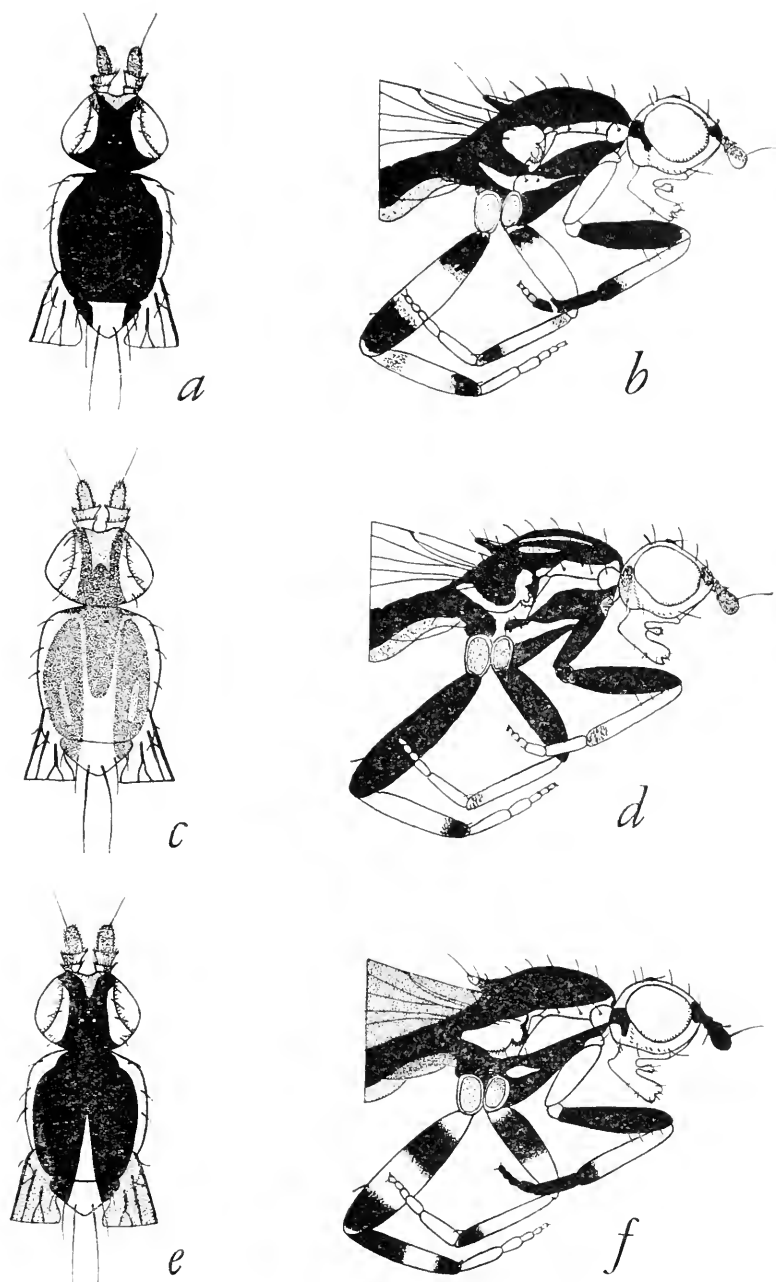


FIGURE 2.—Color patterns of: *a*, *Latheticomyia tricolor*, dorsal view; *b*, same, lateral view; *c*, *L. lineata*, dorsal view; *d*, same, lateral view; *e*, *L. infumata*, dorsal view; *f*, same, lateral view.

Creek Canyon, Coconino National Forest, Ariz., June 21, 1951; 1 female, Madera Canyon, Coronado National Forest, Ariz., June 16, 1951; 1 female, Patagonia, Ariz., June 15, 1951. All paratypes are in the author's collection.

*Latheticomyia infumata*, new species

FIGURE 2,e,f

FEMALE: Face, cheek, clypeus, palpi, and proboscis pale whitish yellow; upper face with numerous (20 or more) small black hairs extending from lunule nearly halfway to oral margin; palpi with scattered black hairs and bristles; behind the center of the eye is a large brown area coinciding in position with the prominent brown pleural stripe.

Color pattern of front as in figure 2,e, the orbits creamy yellow up to the middle orbital, the postlunular triangular area more orange. All antennal segments black on upper and outer surfaces, pale yellow on lower and inner surfaces except that the apical third of inner side of third segment is also black; arista micropubescent, black, its basal joint large, inserted at about one-third from apex dorsally; anterior orbital two-thirds the length of middle one, the latter five-sixths the length of the posterior one.

Color pattern of mesonotum, pleura, and legs as in figure 2,e,f; acrostichal hairs sparse, irregular, the two median rows diverging along the edges of the triangular yellow stripe, the last hair in each row tending to be a bit enlarged. Apical scutellars nearly four times the length of the other two. Halteres yellow. Wings uniformly blackened, a bit darker over the crossveins.

Tergites subshining brownish black dorsally, the last two with some degree of yellow apical margins; all tergites yellow on lateral margins.

Body length (abdomen extended), 4.0 mm.; wing, 3.3 mm.

Types: Holotype female, USNM 62899, Santa María de Ostuma, north of Matagalpa, Nicaragua, June 1954, W. B. Heed collector. There are two paratype females with the same collection data (author's collection). Mr. Heed states that his collections were made mostly on a coffee finca on the western slope of the mountains at an elevation of about 4,000 feet; above the finca was a dense cloud forest and below it the forest was mostly pine.

DISCUSSION

Several years have been spent in an attempt to determine the family affinities of *Latheticomyia*, but it now seems fairly obvious that the particular combination of characters present in these flies does not occur in any described family. On general appearance, a



relationship with the Trigonometopidae would seem to be a possibility, while on the basis of general morphological features the Clusiodidae (Clusiidae) or the Anthomyzidae are suggested. Since some dipterists consider that the Clusiodidae-Opomyzidae-Anthomyzidae form a related group, the fact that *Latheticomyia* shows similarities to both the clusiids and anthomyzids may be significant.

**TRIGONOMETOPIDAE:** On superficial examination *Latheticomyia* bears a certain likeness to *Trigonometopus*, which has, in the past, been variously referred to the Lauxaniidae, Otitidae, Sciomyzidae, and Clusiodidae. In *Trigonometopus*, however, vibrissae are absent, the subcosta is complete and ends independently in the costa, there are no visible costal breaks, the presutural bristle is absent, and the mesopleura always has at least one bristle. None of the described species has a striking body color pattern as in our flies, and most have highly marked wings. In actual fact, therefore, there seems to be little phylogenetic relationship between the two.

**ANTHOMYZIDAE:** *Latheticomyia* bears some resemblance to species of *Anthomyza*, but the resemblances are not very compelling. The arrangement of orbital bristles is similar, the facial structure, vibrissa, oral hairs, bare mesopleura, and distal costal break are all rather alike. In *Anthomyza*, however, there are no presutural dorsocentrals, there are never more than four scutellars, the scutellar disc is always bare, the ocellars are parallel and arise outside the ocellar triangle, the antennae are not at all porrect, the arista is basal, a humeral weakening of the costa is not evident, and the first femur nearly always bears a stout thornlike spine. Since there are still other dissimilar features, it does not seem likely that *Latheticomyia* should be considered as an aberrant anthomyzid.

**CLUSIODIDAE (CLUSIIDAE):** One of the most remarkable features of the clusiids is the great diversity in chaetotaxy, a fact which makes any characterization of the family most difficult. Thus *Latheticomyia* might possibly be forced into this family on the grounds that still greater diversity in bristle patterns is not too unexpected.

Many features of *Latheticomyia* are to be found somewhere among the clusiids: the arista is essentially clusiidlike, the arrangement of orbitals occurs in *Acartophthalmus*, six strong scutellar bristles are present in some species of *Clusia* and *Clusiodes*, presutural dorsocentrals occur in some species of *Clusiodes*, and a humeral costal break is present in *Acartophthalmus* while a distal costal break is characteristic of the other genera. In its gross appearance *Latheticomyia* bears only a weak resemblance to any clusiid; however, *Acartophthalmus*, long considered a clusiid, also bears little resemblance to other members of the family.

If one is inclined to emphasize the direction of the postvertical bristles, as is customary in making family distinctions among the Acalyptratae, then *Latheticomyia* cannot possibly be placed among the Clusioididae. Further evidence for its separation comes from the bare mesopleura, two costal breaks, five pairs of dorsocentrals, longitudinally excavated front, minute hairs on upper face, etc.

*Acartophthalmus* might, with considerable justification, be removed from the Clusioididae. Its general appearance is not that of a clusiid, the arista is clearly inserted basally, the vibrissae are scarcely larger than the following oral hairs, the humeral costal break occurs nowhere else in the family, while the distal costal break, found in all other clusiids, is lacking here. In addition, the large, widely spaced postverticals, the widely separated apices of the auxiliary and first longitudinal veins, and the three simple reclinate orbitals represent features which are not approached elsewhere in the family as far as I have been able to determine. Thus, should *Acartophthalmus* be removed from the family, at least two features of *Latheticomyia* listed above as indicative of a possible relationship to that family would then be eliminated.

Continued discussion of a possible clusiid relationship seems unnecessary. The following brief list of the essentially nonclusiid characters will serve to emphasize the disparities: (1) gross appearance, including pigmentation patterns; (2) convergent postvertical bristles; (3) twice broken costal vein; (4) dorsocentrals in three postsutural and two presutural pairs; (5) bare mesopleura; (6) longitudinally excavated front.

Of the above characteristics, the last five are all deemed of considerable importance in family distinctions. It is my opinion that the disparities noted above are too great, and that the inclusion of *Latheticomyia* in the Clusioididae is not justified.





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A TRIBAL REVISION OF THE BRACHYCYRTINE WASPS OF  
THE WORLD (CRYPTINAE—ICHNEUMONIDAE)

By LUELLA M. WALKLEY <sup>1</sup>

Kriechbaumer (1880) described the genus *Brachycyrtus*, placing it definitely in the "Cryptidae" and near the genus *Hemiteles* because of the incomplete areolet and the exserted ovipositor. He mentioned that the genus reminded one of *Sphinctus* in the form of the thorax and antennae and even of the petiolate abdomen. Schmiedeknecht (1904-1906, pp. 757, 884), when he placed *Brachycyrtus* in the tribe Hemitelini, remarked that it was a peculiar genus with some similarity to *Sphinctus* and, like it, should occupy a special position.

Ashmead (1900, p. 151) listed *Brachycyrtus* (misspelled *Brachycystus*) under the heading "Genera unknown to the author and not classified." Later (1906, p. 174) he described in the Hemitelini the genus *Proterocryptus*, now a synonym of *Brachycyrtus* Kriechbaumer.

Pfankuch (1912, pp. 456-457) seemed to feel that while placement of *Brachycyrtus* was very difficult, it would go best in the Tryphoninae near *Sphinctus*. He believed the form of the head, the apically thickened antennae, the (to him) 3-toothed mandibles, the rhomboid-shaped thorax, the abruptly declivous propodeum, the origin of the radius before the middle of the stigma, and the form of the petiole all precluded placement in the Cryptinae.

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Roman (1915, pp. 5-8) put *Brachycyrtus* in the Ophioninae. He considered it closely related to the Cremastini because of the emarginate eyes, short abscissula of the hindwing, and elongate ovipositor. He also mentioned the similarity of the mandibles of *Brachycyrtus* to those of bassine (Diplazoninae) and bauchine genera.

Cushman (1919, p. 543) established the tribe Proterocryptini for *Proterocryptus* Ashmead, a synonym of *Brachycyrtus*, and placed the new tribe in the Tryphoninae. He compared it with *Sphinctus* Gravenhorst.

Ceballos (1942, pp. 120-121) put *Brachycyrtus* in the tribe Sphinctini (Tryphoninae) on the basis of the short, high, globose thorax, the somewhat apically thickened antennae, and the club-shaped abdomen with slender petiole.

Townes (1944-1945, pp. 22, 756) placed *Brachycyrtus* under the heading "Genera of Uncertain Subfamily," but in 1951 (p. 203) he put the genus in the tribe Brachycyrtini, subfamily Pimplinae. No reasons were given.

Cushman (1936) wrote that "in general form of head and thorax the species are similar to the species of *Chrysopoctonus*." This statement was made in his discussion of the first host record (*Chrysopa* sp.) for the genus. *Chrysopoctonus* Cushman is considered a synonym of *Otacustes* Foerster.

My own tendency was to look for the species in the Pimplinae or Cryptinae when they came infrequently to me for identification. In my opinion the resemblance to the Sphinctini and Cremastini is superficial. Certainly the characters upon which Roman based his placement in the Ophioninae are also found in the Pimplinae. Even the short abscissula of the hindwing is found in the pimpline genera *Aerodactyla* Haliday and *Colpomeria* Holmgren. The Sphinctini seem to belong in the Tryphoninae, probably somewhere near the Exenterini. The ovipositor and general conformation of the abdomen beyond the petiole is typical of the Tryphoninae. The same cannot be said of *Brachycyrtus*.

Specimens identified as *Poecilocryptus nigromaculatus* Cameron by Cushman, and considered cryptine by him, were studied in search of possible relationship to *Brachycyrtus*. The specimens fit the original description of *nigromaculatus* rather well and I believe they are that species. I agree with Dr. Townes (in litt.) that *Poecilocryptus* is pimpline rather than cryptine. However, *Brachycyrtus* does not seem to be closely related to *Poecilocryptus* but to be more cryptine in its affinities. *Poecilocryptus*, unlike *Brachycyrtus*, has typical pimpline claws, lacks a sternaulus, and is in many respects similar in structure to the Theroniini and to the genus *Labium* Brullé, the placement of which has also been questioned.

The apically thickened antennae of *Brachycyrtus*, *Labium*, and *Poecilocryptus* are also found in some species of the hemiteline genus *Otacustes* Foerster, particularly in females of *O. bicolor* (Cushman) as well as in females of *Myersia* Viereck and of hemiteline genera formerly considered pezomachine.

Some earlier authors have considered the petiole of *Brachycyrtus* distinct from that of various cryptine genera. If one will compare the petiole with that of *Mesostenus* and related genera, especially with that of *Mesostenus longicaudis* Cresson (type of *Derocentrus* Cushman), a close similarity will be noted. The shape of the abdomen is also similar.

The Cushman species *Brachycyrtus oculatus* and *B. convergens* show that emargination of the eyes is not a tribal character. The genus as it now stands contains two natural groups, one with strongly emarginate eyes, and the other with eyes either weakly or not at all emarginate (fig. 1,c,d). In this paper I shall consider each group a valid genus of the tribe Brachycyrtini, subfamily Cryptinae. The small wasps (4.5–9 mm. long) belonging to the Brachycyrtini are easily distinguished from those of other tribes in the Cryptinae by the following combination of characters: the short, high, globose thorax; long, slender, more or less club-shaped abdomen; the long antennae thickening toward the apex; the short, broad head, usually broader than the thorax; the flat or somewhat concave clypeus and more or less emarginate upper mandibular tooth; the tiny claws; and the distinctive wing venation (see fig. 1,a,b). In fact, the wing venation is so distinct and so characteristic—differing not only from that of other Cryptinae but from that of other subfamilies as well—that ultimately, with the rearing and collection of more material, additional characters may be found that will necessitate the making of a separate subfamily, the Brachycyrtinae, for the groups.

The two genera, then, that constitute the Brachycyrtini are *Brachycyrtus* Kriechbaumer and *Habryllia*, new genus, and may be separated as follows:

Eyes deeply or strongly emarginate; gastrocoeli present; occipital carina meeting hypostomal carina before base of mandible . . . ***Brachycyrtus*** Kriechbaumer

Eyes weakly or not at all emarginate; gastrocoeli absent; occipital carina not meeting hypostomal carina but going directly to base of mandible.

***Habryllia***, new genus.

Little is known of the biology of the tribe. Species have been recorded from Chrysopidae, *Chrysopa* sp., and "trashbug pupae" (chrysopid pupae), undoubtedly correctly. Indefinite records are: cage of *Alabama argillacea* Heubner; caged cotton buds infested with *Anthonomus vestitus* Boheman; and traps for fruit flies.

*Habryllia*, new genus<sup>2</sup>

Genotype: *Habryllia cosmata*, new species. Present designation.

*Habryllia* resembles *Brachygyrtus* Krichbaumer in its short, high, globose thorax, its more or less club-shaped abdomen, its somewhat apically thickened antennae, its apically emarginate upper mandibular tooth, and its concave clypeus. It differs especially in the characters given in the key and in the position of the prepectal carina, which slopes obliquely back until it attains the position of the postpectal carina and probably fuses with it at least in part. With so few specimens, dissection was not considered. In *Brachygyrtus* the prepectal carina is in normal position for the subfamily, and the postpectal carina absent laterally. *Habryllia* also differs in having longer, more slender antennae with the number of segments of the flagellum varying from 29 to 33 (24 to 27 in *Brachygyrtus*) and with the first flagellar segment about six or seven times as long as wide (three to four times as long as wide in *Brachygyrtus*); and in having the head differently shaped, the temples being longer and sloping inward from the lower margin of the eye (temples shorter and not sloping in *Brachygyrtus*) (see fig. 1, *a, b*).

Material on hand shows this to be a Neotropical genus.

Key to the species of *Habryllia*, new genus

1. Face as long as, or longer than, broad; malar space reduced so that only a line separates margin of eye from base of mandible; apical pleural areas of propodeum lacking. . . . . 2  
 Face broader than long; malar space distinct; apical pleural areas of propodeum present . . . . . 3
2. Propodeum, except lateral pleural areas, granular or shagreened; nervulus postfurcal by about  $1\frac{1}{4}$  times its length.  
     *oculatus* (Cushman), new combination  
 Propodeum polished with a very few large, shallow, scattered punctures; nervulus postfurcal by more than twice its length.  
     *mueselbecki*, new species
3. Antennae each with pale annulus; lateral carinae of propodeum incomplete, not extending to costulae. . . . . *convergens* (Cushman), new combination  
 Antennae without pale annulus; lateral carinae of propodeum extending to costulae. . . . . *cosmata*, new species

*Habryllia oculatus* (Cushman), new combination

FIGURE 1, *f*

*Brachygyrtus oculatus* Cushman, 1936, Proc. U. S. Nat. Mus., vol. 84, pp. 18, 22, fig. 4.

In the Townes collection is a specimen belonging to the genus *Habryllia* which I consider to be this species. I can find no structural

<sup>2</sup> Meaning the small, dainty one; derived from Greek *habros* (delicate, dainty, or pretty) and *-yllion*, a diminutive suffix.



differences. However, the color pattern differs in some respects from that of the type specimen (only two specimens are known to me) and can be within the limits of variation. The abdomen is black where that of the type is brownish, the thorax lacks any black or dark coloration with the exception of the two spots on the propodeum, and the scutellar and postscutellar spots are as in the type specimens; the leg markings, while similar in shape and distribution, are black in the Townes specimen; the black of posterior part of head is not separated from the ocellar spot and the head itself is paler, more whitish than yellow. More material is needed to show definitely whether it belongs here or is new. The specimen was collected in Puerto Cabello, Venezuela, Feb. 4, 1940, by P. J. Anduze.

*Habryllia muesebecki*, new species

FIGURE 1,c,e

This new species is stouter than any other brachygyrtine species I have seen.

Holotype, female: Length 6 mm.; forewing 4.5 mm.; antenna 6 mm.; ovipositor sheath barely 1.3 mm.

Head yellowish white, similar to that of *H. oculatus* (Cushman) in shape but differing in coloration by having only the ocellar triangle black, the occipital area being more or less testaceous; antennae reddish brown with apical segments darker; flagellum with 31 segments, first segment longer than segments 2 and 3 together.

Thorax testaceous with the markings on mesopleura, metapleura, and the petiolar area of propodeum as well as a transverse area just below the costulae yellowish white; the postscutellum with the discal area dark brown or blackish; scutellum broader in comparison with its length than in *oculatus*; the postscutellum distinctly transverse, the disk being  $1\frac{1}{2}$  times as broad as long. As noted in the key to species, the propodeum is polished, without shagreening or granulation, and with only a very few large scattered punctures. Forewing with nervulus postfural by more than twice its length.

Abdomen black with apices of segments 2-7 yellowish white; two lateral transverse pale spots, devoid of pubescence, at base of third segment; legs yellowish white with dorsal face of tibiae of front and middle legs brownish at least two-thirds of distance from apex to base; hind coxae dark brown or blackish at base extending posteriorly one-third of distance to apex on dorsal face and at least one-half of distance to apex on lateral face; trochanters more or less blackish; inner and outer faces of hind femora with blackish streak; hind tibia blackish at base and apex with the two areas connected on the outer

face; tarsi of middle and hind legs brownish. Ovipositor reddish brown, sheaths blackish.

*H. muesebecki* also differs from *oculatus* in the shape of the occipital carina and of the eyes. Viewed laterally the occipital carina is raised or flanged in *oculatus* but not in this new species. The eye of *oculatus* seems to be widest distinctly before the middle, while in *muesebecki* it seems widest just before or almost at the middle (fig. 1,e,f).

Described from a unique female collected at Rio de Janeiro, Brazil, September 1938 by R. C. Shannon. This specimen is in the U. S. National Museum collection under type No. 62053.

This new species is named in honor of C. F. W. Muesebeck, who, despite his heavy schedule and many obligations, still takes time to aid or advise the many who ask his assistance.

***Habryllia convergens* (Cushman), new combination**

*Brachycyrtus convergens* Cushman, 1936, Proc. U. S. Nat. Mus., vol. 84, pp. 18, 20, fig. 2.

Cushman's description of this species is so complete that little more need be done than to stress certain characters. This is the only species with annulated antennae known to me. Like *H. muesebecki*, it is stouter in general conformation than the remaining species in the genus. Further discussion will be found under *H. cosmata*, new species.

Thus far this species is known only from the unique female taken at Cano Saddle, Gatún Lake, Panamá.

***Habryllia cosmata*, new species**

FIGURE 1,a

Holotype, female: Length barely 5 mm.; forewing 3.5 mm.; antenna 4.55 mm.; ovipositor sheaths 1 mm.

Head polished, with minute, scarcely visible punctures on the face; eyes somewhat convergent anteriorly, weakly emarginate; malar space barely one-half the basal width of mandible; temples, viewed dorsally, about one-half the width of the eye; ocellar triangle transverse; antennal flagellum with 30 segments, the basal segment fully as long as the second and third combined.

Thorax at least as deep as, or a little deeper than, long; polished and sparsely punctate on the mesoscutum and mesopleura; propodeum, except polished metapleura, with more or less of the other areas appearing finely granular, spiracles small, elongate-oval, areola and petiolar area confluent, first and second lateral basal areas confluent; scutellum longer than wide, lateral carinae reaching apex; postscutel-

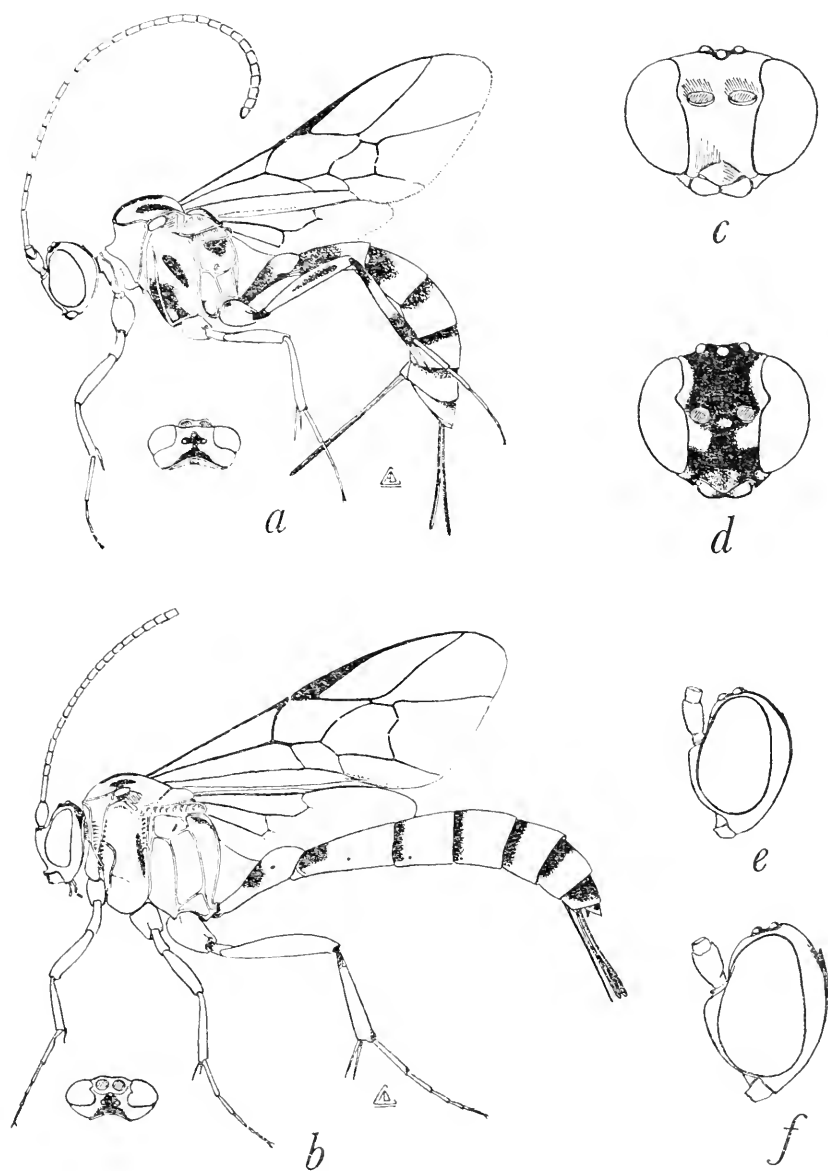


FIGURE 1.—*a*, *Habryllia cosmeta*, new species, lateral view, and dorsal view of head; *b*, *Brachycyrtus baltazaræ*, new species, lateral view, and dorsal view of head; *c*, *Habryllia muesebecki*, new species, front view of head; *d*, *Brachycyrtus ornatus* (Kriechbaumer), front view of head; *e*, *Habryllia muesebecki*, new species, lateral view of head; *f*, *H. oculatus* (Cushman), lateral view of head. Drawn by Arthur D. Cushman, Entomology Research Branch, U. S. Department of Agriculture.

lum roundish with lateral carinae; wings hyaline, iridescent, pubescence at tip of forewing dense enough to make tip appear darker in transmitted light, nervulus postfurcal by one and one-third its length.

Abdomen polished, minutely punctate, punctures on first tergite very sparse; petiole flat dorsally, postpetiole widest at the spiracles, its apex not quite twice as wide as petiole base.

Head and thorax yellow with the following black: ocellar triangle and a narrow stalk extending back from ocellar line and widening greatly to occipital carina then narrowing to foramen magnum; two spots on the mesopleuron, the upper one running diagonally across the middle, the other below and extending onto the venter; three stripes on the mesoseutum, the middle one beginning at the base and running about two-thirds the distance to the apex, the two lateral stripes beginning at the basal third and extending to the apex; most of disk of scutellum; disk of postscutellum; a spot on each side of the propodeum just dorsal and anterior to the propodeal spiracle. Legs yellow except the following which are piceous or dark brown: a small basal spot on hind coxa, most of hind trochanters, stripe on outer side and inner face of hind femur, basal and apical annulus on hind tibia, middle and hind tarsi, and last two segments of each front tarsus. Ovipositor sheaths, petiole, and base of postpetiole black, rest of postpetiole yellow; remainder of abdominal tergites reddish yellow with more than basal half of tergites 2 and 3 and less than basal half of remaining tergites blackish or dark brown. Antennae and wing nervures yellowish brown; ovipositor reddish brown. Type has left forewing and left middle leg missing.

Allotype, male. Similar to female. Black spots on mesopleuron smaller, the lower one almost nonexistent. Antennal flagellum with 29 segments.

This species is very close to *H. convergens* (Cushman), from which it may be distinguished by the complete lack of a pale annulus on the antenna; by the lateral carinae reaching the costulae; by the more slender ovipositor; and by the slightly longer and more slender basal flagellar segment of the antenna. Color pattern of the two species is very similar. *H. convergens* has less black on legs and less reddish-yellow on abdomen.

Described from two specimens, female and male, from St. Augustine, Trinidad, British West Indies, collected in May 1953 by F. D. Bennett. A third specimen is too broken to include in the type series.

Holotype, female, and allotype, male, are in the U. S. National Museum collection under type No. 62052.

A headless specimen from Venezuela in the Townes collection is either this species or a new species closely related to *cosmeta*.

Genus *Brachycyrtus* Kriechbaumer

*Brachycyrtus* Kriechbaumer, Corres.-Blatt. Zool.-Min. Ver. Regensburg, vol. 34, p. 161, 1880. Genotype: *Brachycyrtus ornatus* Kriechbaumer, by monotypy.

*Proterocryptus* Ashmead, Proc. U. S. Nat. Mus., vol. 30, p. 174, 1906. Genotype: *Proterocryptus nawaii* Ashmead, by monotypy.

*Vakau* Cheesman, Ann. Mag. Nat. Hist., ser. 10, vol. 1, p. 189, 1928. Genotype: *Vakau taitensis* Cheesman, by monotypy and original designation.

*Brachycyrtomorpha* Blanchard, An. Soc. Cient. Argentina, vol. 131, p. 165, 1942. Genotype: *Brachycyrtomorpha crossi* Blanchard, by monotypy and original designation.

Genotype: *Brachycyrtus ornatus* Kriechbaumer, by monotypy.

The members of this genus, type genus of the tribe Brachycyrtini, are more or less brightly colored, usually black and yellow or white, rufous or testaceous brown and yellow or yellowish white, and more or less patterned. In addition to the tribal characters heretofore mentioned and the characters given in the generic key, they are further identified by the antennae having 24 to 27 segments with the first flagellar segment three to four times as long as wide; by the head being more than twice as broad as long with very short, slightly convex temples (fig. 1, *b*); by the petiole with the sternite straight or more or less upcurved apically; the usually short but distinct sternardus; and the propodeum perpendicular beyond the short basal area.

The synonym *Brachycyrtomorpha* has been credited previously by some authors to Kriehbaum de la Vega (1940). However, under the International Rules of Zoological Nomenclature (Article 25, as amended) the genus must date from 1942 with Blanchard as its author, since before that date there had been no summary of characters, no bibliographic reference, and no type designation.

Key to the species of *Brachycyrtus*

1. Propodeum with dense whitish pubescence and completely areolated, the areola separated from the petiolar area . . . . . 2
- Propodeum with pubescence not dense and with areola and petiolar area confluent . . . . . 3
2. Thorax reddish yellow, with whitish markings . . . . . *pretiosus* Cushman
- Thorax whitish, with reddish yellow and piceous markings. . . . . *crossi* (Blanchard)
3. Thorax black or blackish, with pale markings . . . . . *ornatus* Kriechbaumer
- Thorax yellow or yellowish, marked with brown or black . . . . . 4
4. Thorax yellow, faintly marked with reddish yellow or testaceous. . . . . *australis* Roman
- Thorax yellow, marked with black or dark brown . . . . . 5
5. Size large, more than 8 mm. in length; abdomen yellow with black band at base of each of segments 2-6. . . . . *baltazarae*, new species
- Size smaller, 7 mm. or less in length; abdomen dark brown or black with yellow band at or near apex of each of segments 1-7 . . . . . 6

6. Mesopleuron black with central section yellow or testaceous and usually elongate. . . . . **nawaii** (Ashmead)  
 Mesopleuron yellow . . . . . **taitensis** (Cheesman)

*Brachycyrtus* (sic) *aporiae* Okamoto (1921, pp. 64-65, pl. 5, fig. 15), as Cushman previously noted, does not belong here. It belongs in the Hemitehini.

***Brachycyrtus pretiosus* Cushman**

*Brachycyrtus pretiosus* Cushman, 1936, Proc. U. S. Nat. Mus., vol. 84, pp. 18, 19, fig. 1, 1936.

Cushman's excellent description errs in one respect. He stated that the occipital carina extended straight to the base of the mandible. This character, for various reasons, is either very difficult to see or not visible on the Cushman specimens. Fortunately, specimens since added to the U. S. National Museum collection definitely show that the occipital carina meets the hypostomal carina before the base of the mandible and does not, as Cushman thought, extend to the base. This species shows very little color variation. It and *crossi* differ from other species in the genus by the short epomiae, which reach only a little more than half the distance to the dorsal margin of the pronotum.

*B. pretiosus* is known only from Florida.<sup>3</sup> The four additional specimens, reared from "trashbug pupae" (chrysopid pupae), are from Sloan's Grove, Tampa, and Haines City, Florida.

***Brachycyrtus crossi* (Blanchard)**

*Brachycyrtomorpha crossi* Blanchard, ("in lit."), Kreibohm de la Vega, Rev. Ind. Agr. Tucumán, vol. 30, Nos. 7-9, p. 170, fig. 18, 1940. Nomen nudum.

*Brachycyrtomorpha crossi* Blanchard, An. Soc. Cient. Argentina, vol. 134, pp. 105-107, fig. 6, 1942.

(*Brachycyrtus*) *crossi* Kreibohm de la Vega; Townes, Mem. Amer. Ent. Soc., No. 2, pt. 2, p. 756, 1945.

Kreibohm de la Vega had no intention of validating the name *crossi*, which he attributed to Blanchard, but he certainly would have done so had the figure (a photograph) not been too poor to distinguish it from other brachycyrtine species known at the time.

*B. crossi*, most closely related to *B. pretiosus* Cushman, is immediately distinguished from it and all other known species of *Brachycyrtus* by the whitish thorax with three broad, reddish brown stripes. Blanchard speaks of the thorax as being whitish yellow, and the scutellum pale ivory. In the specimens before me the scutellum and thorax are the same color, though the spaces between the ferruginous stripes of the scutum are slightly tawny or yellowish. Otherwise the two males agree very well with Blanchard's description. The female differs from the male in having the spots of the pleural areas paler and

in having the abdomen dark brown or blackish varying to testaceous brown with preapical whitish bands or spots on segments 1-6 only and not on segment 7 as has the male. Structurally, *crossi* and *pretiosus* are very similar, the only difference being the shorter malar space of *pretiosus*.

Blanchard and Kreibohm de la Vega say the specimen they saw was reared from *Alabama argilacea* Huebner, presumably in Tucumán, Argentina. However, Kreibohm was more accurate in saying "en la jaula de *Alabama*" (in the cage of *Alabama*). The three specimens before me came from Piura, Perú, from caged cotton buds infested with *Anthonomus restitus* Boheman. It seems reasonable to assume chrysopid pupae were present.

***Brachycyrtus ornatus* Kriechbaumer**

FIGURE 1,d

*Brachycyrtus ornatus* Kriechbaumer, Corres. Blatt. Zool.-Min. Ver. Regensburg, vol. 34, Nos. 11-12, pp. 163-164, 1880 (♀).

*Brachycyrtus ornatus* Kriechbaumer; Pfankuch, Deutsche Ent. Zeitschr. (1912), pt. 4, pp. 456-457, figs. 1-3, 1912 (♂).

*Brachycyrtus chrysopae* Walley, Canadian Ent., vol. 72, p. 86, 1940 (♀). New synonymy.

Dr. René Malaise of the Naturhistoriska Riksmuseum, Stockholm, Sweden, always a most helpful person, lent me for study a female specimen identified by E. Clément as *Brachycyrtus ornatus* Kriechbaumer. It fits the original description quite well. G. S. Walley not only sent for study a female specimen of *B. chrysopae*, which like the type specimen came from southern British Columbia, but also sent notes on the type, for which I am grateful. In the Townes collection, kindly lent me for study by H. K. Townes, is a series consisting of eight specimens taken by him and his wife at Takoma Park, Md. These Mr. Walley had checked with his holotype. This series plus additional specimens from the Townes collection and the U. S. National Museum collection show quite well the extent of variation as well as the constant characters. With this material it was easy to see that *ornatus* and *chrysopae* are synonymous. Unfortunately, the earlier descriptions of *ornatus* stressed the tribal characters and color. Cushman had not seen any specimens of the genotype so could not include it in his 1936 key to the specimens of *Brachycyrtus*.

This is the darkest of the known species belonging to *Brachycyrtus* and varies in size from 5 to 6 mm. The identifying characters other than color pattern are: Epomiae nearly attaining the dorsal margin of the pronotum; malar space about one-half as long as width at base of mandible; and the nervulus postfureal by only little more than half

its length (in *pretiosus* Cushman and *rossi* (Blanchard) the nervulus postfurcal by about its own length). The anterior margin of the scutellar groove is carinate as in *nawaii* (Ashmead), but unless the light is right it may escape notice since the carina projects posteriorly instead of dorsally.

*B. ornatus* varies from dark brownish to blackish, with yellowish markings of thorax varying considerably in extent, especially on the propodeum. In the specimens studied the propodeum varies from all black, or black with a small brownish spot on each side of the petiolar area just below the basal transverse carina, to mostly yellow with only the basal and lateral pleural areas dark. In the European specimen the dark areas are brownish as well as blackish and the yellow of the propodeum a more reddish yellow. In some specimens the petiolar area is all yellowish while in others it is more or less infusate. The flagellum of the antenna has 24 or 25 segments in the female, and 25 in the male. Of the two males studied only one had the antennae unbroken. The male squamae that tend to be slender apically in the Brachycyrtini are more so in this species and strongly resemble those of *Pseudischnus* males in this respect.

*B. ornatus* is holarctic in distribution. It has been taken in both Europe and North America. The North American specimens before me are from Robson, British Columbia; Mayo and Takoma Park, Md.; Hocking County, Ohio; and near Roosevelt Lake, Ariz. The type of *chrysopae* was reared from an unknown chrysopid.

#### *Brachycyrtus australis* Roman

*Brachycyrtus australis* Roman, Ark. Zool., vol. 9, No. 9, p. 6, 1915 (♀).

*Brachycyrtus australis* Roman, Cushman, Proc. U. S. Nat. Mus., vol. 84, p. 18, 1936.

Dr. Malaise sent for study the type specimen, the antennae of which were broken. Roman listed the number of flagellar segments as 27. The apical segments remaining are longer and less thick in proportion than those of *B. ornatus*. This little species, as noted in the key, has fewer dark markings than any of the other species; the markings on the head and thorax, especially, being light brownish or testaceous. Roman's complete description notes the small oval propodeal spiracles. *B. australis* is the only species of *Brachycyrtus* with short-oval spiracles. The rest of the species of the genus have elongate-oval propodeal spiracles. It might also be noted that the malar space is shorter than that of *B. ornatus*, being about one-third the basal width of mandible.

Known only from a single specimen taken at Broome, Australia, June 1911.



*Brachycyrtus baltazarae*, new species

FIGURE 1,b

This new species can be immediately recognized by its large size. The only known specimen, a female, is approximately 9 mm. in length. All other known species in the genus measure 6 mm. or less. The new species is further distinguished by the lack of costulae on the propodeum.

Head yellow; ocellar triangle black, joining black spot extending dorsally and laterally to occipital carina but with lateral limits visible dorsally; scape and pedicel yellow below, blackish above; flagellum testaceous below, darker above (apical segments missing from both antennae). Thorax yellow, rectangular median black spot on scutum, flanked on each side by elongate triangular black spot, scutellar fovea and adjoining area of scutum black, elongate black spot on pleuron near mesopleural suture, anterior black spot on lateral basal areas of propodeum. Legs yellow except apices of femora and tibiae, apical tarsal segments, and bases of hind trochanters and tibiae, all of which are more or less brownish or blackish; wings hyaline, venation dark brown. Abdomen yellow, petiole blackish at extreme base (difficult to see) with a laterally elongate blackish band before the spiracles, blackish band at base of segments 2-6, segment 7 mostly brownish or blackish except narrow band at apex; ovipositor sheaths blackish.

Head lightly but closely punctate, first flagellar segment of antenna  $3\frac{1}{2}$  times as long as wide. Thorax strongly but rather closely punctate except propodeum, which is mostly granular with scattered punctures basally; epomiaae flangelike and joining dorsally; scutellar fovea carinate anteriorly and crossed by several carinae; punctate scutellum with lateral carinae flangelike at fovea; postscutellum small and shining; propodeum lacking costulae, areola and petiolar area fused; propodeal spiracles slitlike and proportionately larger than in other known species of the genus. Forewing with nervulus postfurcal by about one-third its length; cubitus, between intercubitus and second recurrent, fully  $3\frac{1}{2}$  times as long as intercubitus. Petiole widest at spiracles then narrowing so that its apical width is about three-fourths that at spiracles. Ovipositor sheaths only very slightly longer than petiole.

Described from the unique female collected by F. R. Candelaria, Sept. 17, 1953, on Mount Maquilung, Philippine Islands, and named in honor of Miss Clare Baltazar, entomologist with the Bureau of Plant Industry, Manila, Philippine Islands, who so kindly sent the specimen. The holotype is in the U. S. National Museum collection under type No. 62774.

*Brachycyrtus nawai* (Ashmead)

*Proterocryptus nawai* Ashmead, Proc. U. S. Nat. Mus., vol. 30, p. 174, pl. 12, fig. 3, 1906.

(*Brachycyrtus*) *nawai* (Ashmead); Roman, Ark. Zool., vol. 9, No. 9, p. 5, 1915.

*Proterocryptus nawai* Ashmead; Cushman, Proc. U. S. Nat. Mus., vol. 55, p. 543, 1919.

*Brachycyrtus nawai* (Ashmead); Cushman, Proc. U. S. Nat. Mus., vol. 84, pp. 18, 23, fig. 4, 1936.

Ashmead's type specimen is from the Palearctic region (from Japan), and is very closely related to *B. ornatus* Kriechbaumer, from which it can be separated principally by color and by the shape and length of the epomiae. In *B. nawai* the epomiae reach the dorsal margin of the pronotum and are strongly developed or flanged, but in *B. ornatus* they do not quite reach the dorsal margin and are less strongly developed or flanged. Additional material may show the length of the epomiae more variable in both species. In color pattern the two species are very close, the pattern differing especially on the head and mesopleuron. *B. ornatus* has the black spot behind the antennae fused with the black of the ocellar triangle while in *nawai* the two spots are separated. *B. nawai* also has more yellow on the mesopleuron, including a more or less rectangular yellow spot near the center. *B. ornatus* has no such spot.

In addition to the type from Japan, I have seen three specimens from the Philippines. One, in the U. S. National Museum collection, Cushman mentioned as being *nawai* in his 1936 paper. A second specimen in the Museum collection, from Babatan Island, and one from the Townes collection, from Gapan, may prove, with additional material to show amount of variation, to be a distinct species. The malar space seems a little shorter and the pale bands of the abdomen wider medially on segments 2 and 3. I can find nothing else to differentiate these specimens, so at present can only consider them as being *nawai*.

The distribution for *Brachycyrtus nawai* is Atami, Japan, and Manila, Luzon Island, Babatan Island, and Gapan Island, all in the Philippines. The specimen from Manila was reared from cocoon of *Chrysopa* sp.

*Brachycyrtus taitensis* (Cheesman)

*Vakau taitensis* Cheesman, Ann. Mag. Nat. Hist., ser. 10, vol. 1, No. 2, p. 189, fig. 7, 1928.

(*Brachycyrtus*) *taitensis* Cheesman; Townes, Mem. Amer. Ent. Soc. No. 2, pt. 2, p. 756, 1945.

I have seen no specimen of this species. The "longitudinal striate puncturation" of the mesoscutum and the "pectinate inner spine" of the middle tibia should immediately identify this species. The

original description speaks of the species as being "Matt; minutely granulate, with fine shallow puncturation and a sparse covering of pale yellow hairs." The other species of the genus are more shining than matt, except sometimes the propodeum.

The three specimens were taken at various localities on Tahiti, Society Islands.

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# PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM



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## A NEW SPECIES OF CANDACIA (COPEPODA: CALANOIDA) FROM THE WESTERN NORTH ATLANTIC OCEAN

By ABRAHAM FLEMINGER and THOMAS E. BOWMAN

The new species of *Candacia* described below was discovered independently by the authors while engaged in studies of plankton collections made by the U. S. Fish and Wildlife Service (USFWS). The plankton tows were made off the southern Atlantic coast of the United States by the *Theodore N. Gill* and in the Gulf of Mexico by the *Alaska* as part of general oceanographic surveys of the two regions.

In addition to the new species described below, seven known species of *Candacia* have been found in the collections. *C. bipinnata* Giesbrecht, *bispinosa* Claus, *curta* Dana, *longimana* Claus, *pachydactyla* Dana, and *simplex* Giesbrecht occurred in both regions surveyed, whereas *armata* Boeck has been found only in collections made at some of the most northern stations occupied by the *Gill*, off Beaufort, N. C. These stations appear to represent approximately the southern boundary of the distribution of this species along the Atlantic coast of the United States. As pointed out by Thompson and Scott (1903, p. 250), Brady's (1884, p. 68) records from *Challenger* stations are probably erroneous. The only other published records from Indo-Pacific or tropical western Atlantic localities are contained in C. B. Wilson's *Carnegie* (1942) and *Albatross* (1950) reports. Examination of *Carnegie* and *Albatross* specimens in the U. S. National Museum

(USNM) identified by Wilson as *C. armata* was carried out. Almost all of Wilson's determinations proved to be erroneous; *C. armata* was not present at any of the *Carnegie* stations and only at *Albatross* station 2195 (lat.  $39^{\circ}44'$  N., long.  $70^{\circ}03'$  W., off Cape Hatteras).

*C. aethiopica* Dana, a widespread species in temperate and tropical waters of all the oceans, was not found in either the *Alaska* or *Gill* collections. It will probably be found at least in the region covered by the *Gill*, since it has been reported from the Bermuda area (Moore, 1949), and Mr. Philip St. John (personal communication) has found it in plankton hauls made off the coast of North Carolina.

*Candacia norvegica* (Boeck), found in the cooler part of the North Atlantic Ocean, appears to be limited to waters of lower temperature than those surveyed by the *Alaska* and the *Gill*. In Wilson's *Carnegie* and *Albatross* papers this species was reported to have been found in the Sargasso and Caribbean regions and in many parts of the Pacific Ocean. As in the case of *C. armata*, Wilson's determinations have been found to be incorrect. *C. norvegica* was not present in any of the *Albatross* or *Carnegie* material in the U. S. National Museum.

*Candacia paenelongimana*, new species

FIGURES 1; 2, a-g

LOCALITIES AND MATERIAL: Gulf of Mexico: Lat.  $23^{\circ}35'$  N., long.  $82^{\circ}23'$  W. (USFWS *Alaska* cruise 4, station 29, Jan. 19, 1952, 1 meter depth of tow, one female); lat.  $23^{\circ}31'$  N., long.  $86^{\circ}44'$  W. (*Alaska* cruise 4, station 36, Jan. 24, 1952, 1 meter depth of tow, one female).

Gulf Stream: Off Florida coast, lat.  $27^{\circ}40'$  N., long.  $79^{\circ}41'$  W. (USFWS *Theodore N. Gill* cruise 1, station 6, Feb. 17, 1953, 60 meters depth of tow, one female); off South Carolina coast, lat.  $32^{\circ}41'$  N., long.  $77^{\circ}03'$  W. (*Gill* cruise 1, station 62, Mar. 3, 1953, 75 meters depth of tow, one female, one male).

MEASUREMENTS: All measurements made from dorsal view along midsagittal plane; cephalothorax measured from anteriormost margin of forehead to posterior margin of intersegmental fold between thoracic fusion segment IV-V and genital segment; length of abdomen from anterior margin of genital segment to articulation between fifth innermost seta and right furcal ramus. Measurements made at  $100\times$  magnification with aid of ocular micrometer, specimens immersed in solution of 50 percent glycerine, 50 percent water. Slender glass rods used to support cephalothorax and abdomen in horizontal position during measurements of each.

The total length and cephalothorax-abdomen ratio, presented in that order, for individuals collected at different localities are as follows: Adult females: holotype, 2.92 mm., 4.1 : 1; paratypes, 2.54

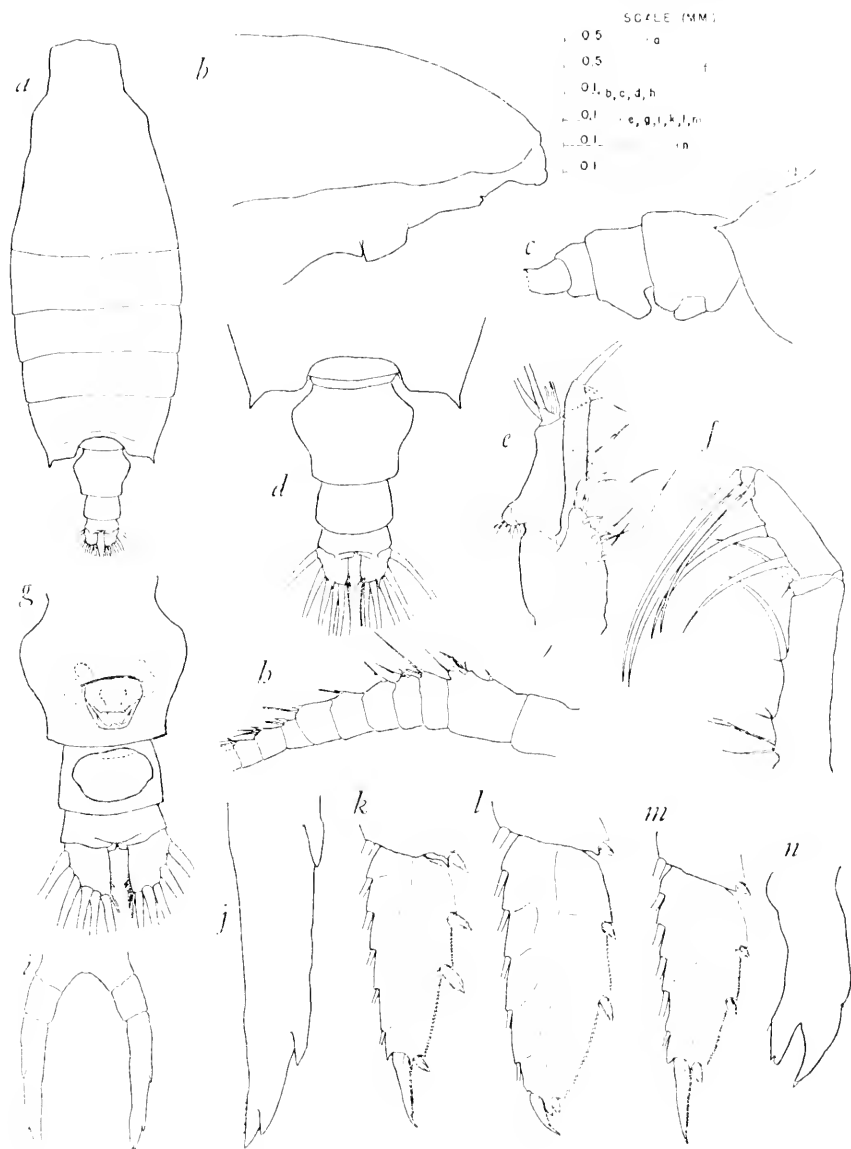


FIGURE 1.—*Candacia pacnelongimana* new species, female (*a-j* and *n* are holotype, *k-m*, paratype): *a*, dorsal view; *b*, cephalon, lateral view; *c*, abdomen, lateral view; *d*, abdomen, dorsal view; *e*, second maxilla; *f*, maxilliped; *g*, abdomen, ventral view; *h*, proximal portion of first antenna; *i*, fifth legs; *j*, ramus of fifth leg, distal half; *k*, third exopodal segment of fourth leg; *l*, third exopodal segment of third leg; *m*, third exopodal segment of second leg; *n*, mandible, gnathal lobe.

mm., 3.9 : 1 (*Alaska* station 29); 2.57 mm., 3.7 : 1 (*Gill* station 62) 2.66 mm. (*Gill* station 6). Adult male: allotype, 2.49 mm., 3.4 : 1.

DIAGNOSIS: Adult female; similar to *C. longimana* (Claus) with respect to cephalothorax, cephalic appendages, and swimming legs 1-4 (fig. 1, *e, f, h, k-n*).

Abdominal details differing from *longimana*: Genital segment with somewhat angular lateral swellings, greatest width anterior to mid-length of swellings (fig. 1, *d, g*); measured at greatest width, genital segment wider than long (0.82-0.85 : 1); second abdominal segment produced ventrad in a broad lobiform process (fig. 1, *e*); process extends ventrad and somewhat anteriad, almost reaching posteroventral margin of genital segment.

Fifth legs differing from *longimana*; spines of ramal segment small; ramus with two apical subequal spines, two appressed spines along lateral margin; medial margin of ramus with longitudinal row of about five small denticles near apex (fig. 1, *i, j*).

Adult male similar to *longimana* with respect to cephalic appendages and swimming legs 1-5.

Posterior process of right fifth thoracic segment relatively longer and of rather different form than that of *longimana*. Seen from above (fig. 2, *c*) process tapers gradually and turns slightly outward at tip; in lateral view (fig. 2, *b*) it curves upward to tip, which has an expansion on its posterior side.

Genital segment (fig. 2, *a, d*) similar to that of *longimana*, but process on right side without thickening near the middle as characteristic of *longimana*.

Fifth legs (fig. 2, *e*) like those of *longimana* in all details.

Types: Holotype, USNM 98618, female, *Alaska* cruise 4, station 36. Allotype, USNM 98619, male, *Gill* cruise 1, station 62. Paratypes: USNM 98622, female, *Alaska* cruise 4, station 29; USNM 98621, female, *Gill* cruise 1, station 6; USNM 98620, female, *Gill* cruise 1, station 62.

ADDITIONAL DESCRIPTION: Abdominal segments plus furca with following proportions: Female (based on holotype), 48.5, 25.0, 12.0, 14.5=100; male, 37.5, 30.0, 27.0, 12.5, 20.0=100.

FIGURE 2.—*a-g*, *Candacia paenelongimana* new species, male allotype: *a*, dorsal view; *b*, fifth thoracic segment and first abdominal segment, seen from the right side; *c*, posterior corner of right fifth thoracic segment, dorsal view; *d*, process of first abdominal segment, dorsal view; *e*, fifth legs; *f*, right first antenna, segments 15-19, dorsal view; *g*, right furcal ramus, dorsal view. *h-l*, *Candacia longimana* (Claus): *h*, abdomen, dorsal view, male from South Pacific, USNM 80116; *i*, portion of fifth thoracic and first abdominal segments, dorsal view, male from same lot as *h*; *j*, posterior corner of right fifth thoracic segment, dorsal view, male from Carnegie Sta. 66, off Chile, USNM 80115; *k*, same, lateral view; *l*, fifth legs, female, *Gill* Cruise 1, Sta. 71, off North Carolina; *m*, abdomen, lateral view, same specimen. *n*, *Candacia chirura* Cleve, abdomen, lateral view, from Farran (1929).



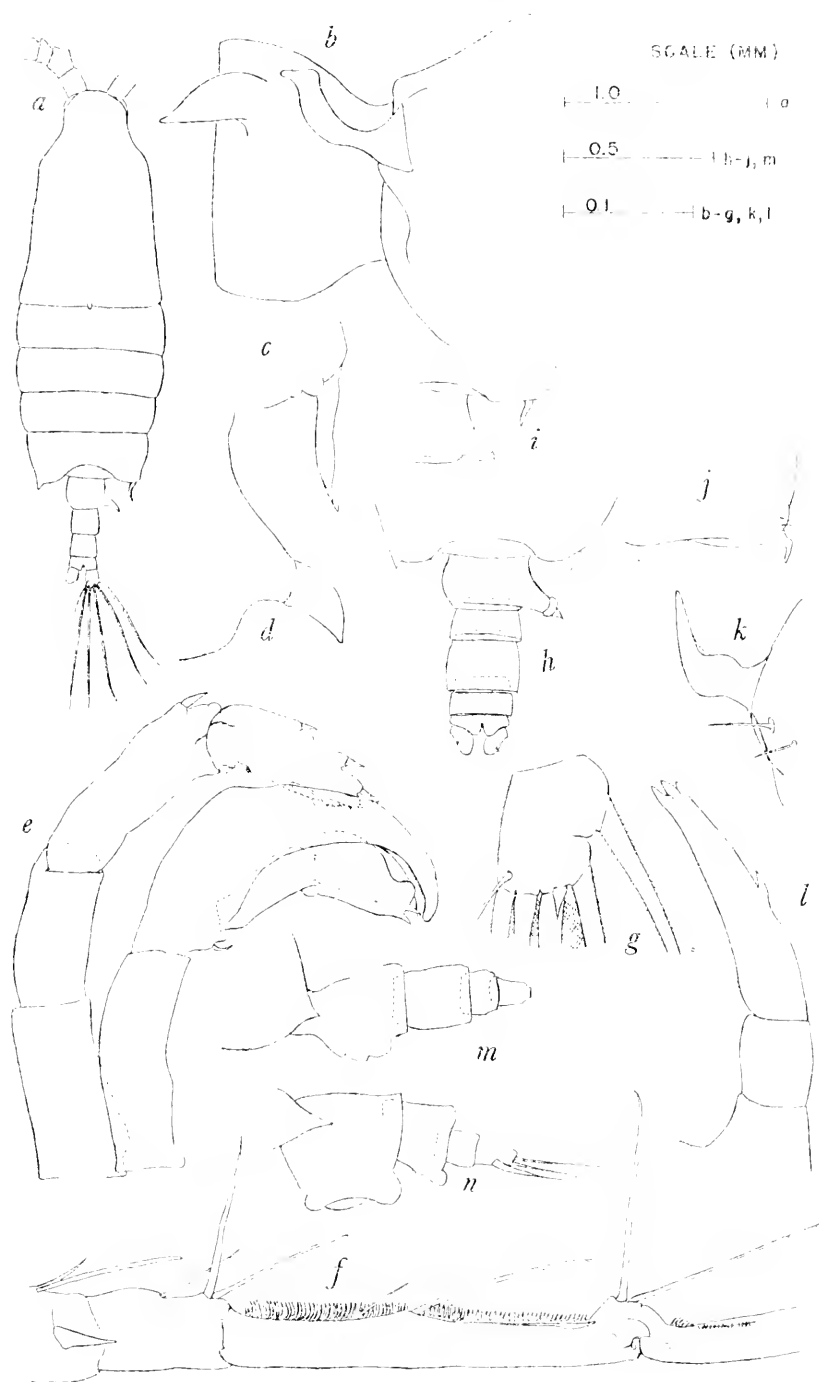


FIGURE 2.—Explanation on facing page.

Cephalothorax-abdomen length ratio of female *longimana* Claus, according to Giesbrecht (1892, p. 428), approximates  $2.9 \pm .3:1$ . However, ratios of *longimana* collected by Gill and Alaska similar to range in *paenelongimana*; a female *longimana* from Gulf of Mexico (unpublished data; lat.  $23^{\circ}50'$  N., long.  $82^{\circ}19'$  W., Jan. 19, 1952, 1 meter depth) with ratio of 3.8:1; two *longimana* females from off Cape Lookout (unpublished data; lat.  $34^{\circ}03'$  N., long.  $75^{\circ}15'$  W., Mar. 6, 1953, 35 meters depth) with ratios of 3.6:1 and 4.1:1. Cephalothorax-abdomen length ratio, therefore, appears to be of no value in distinguishing between individual females of the two species.

Genital segment tends to be longer and furcal rami shorter in female *paenelongimana* as compared to available specimens and Giesbrecht's figures (1892, pl. 39, figs. 4, 6) of *longimana*.

REMARKS: The female can be easily recognized by the characteristic ventral process of the second abdominal segment. While processes from the ventral surface of this segment are developed to varying degrees in several species of *Candacia*, the process is directed anteriad only in *paenelongimana*. Both *Candacia chirura* Cleve (fig. 2,*n*) and *C. armata* (Boeck) have conspicuous processes, directed posteriad.

The male can easily be confused with the male of *longimana*, but can be distinguished by the shape of the process on the right side of the fifth thoracic segment, especially when examined from the side. In *longimana* this process is somewhat variable, but is relatively shorter and heavier than in the single male *paenelongimana*. In dorsal view (fig. 2,*h-j*) it is more pointed and usually curves medially. Seen laterally (fig. 2,*k*) it bends abruptly upward just beyond the thickened middle and narrows uniformly to the pointed distal end. A number of male specimens of *longimana* from both the Atlantic and Pacific Oceans have been examined; in none of them did this process closely resemble that of *paenelongimana* with its uniform curvature and expanded apex.

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**A NEW PINECONE FISH, *MONOCENTRIS REEDI*, FROM CHILE,  
A NEW FAMILY RECORD FOR THE EASTERN PACIFIC**

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By LEONARD P. SCHULTZ

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Dr. Edwyn P. Reed<sup>1</sup> recently sent to me for identification a photograph of, and later at my request the dried specimen of, a pinecone fish of the family Monocentridae taken off the coast of Chile in the Juan Fernández Islands at a depth of 200 to 250 meters. A photograph of the specimen was also sent to H. W. Fowler, who published a note entitled "The Pinecone Fish, *Monocentris japonicus* (Houttuyn) at Juan Fernandes, Southeast Pacific" (Fish Culturist, reference below).

This unique specimen represents the first record for the family in the eastern Pacific. Upon comparison of the specimen with the three other known species referred to the family, I observed that it differed in several characteristics and represented a new species.

The occurrence in the eastern American Pacific of another of the tropical central-western Pacific fauna indicates once more that the eastern Pacific fish fauna is more closely related to that of the Indo-Pacific than formerly supposed. These two faunas have differentiated mostly on the species level and less so at the generic level.

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<sup>1</sup> Chief of the biological department, Dirección General de Pesca y Caza, Valparaíso, Chile.

*Monocentris reedi*, new species

## PLATE I

*Monocentris japonicus*, Fowler, Fish Culturist (Philadelphia), vol. 34, No. 9, p. 65, fig., May 1955 (Juan Fernández Islands, Chile).

*Monocentris*, Reed, Inv. Zool. Chilenas, vol. 2, No. 8, p. 131, fig. 1955 (Juan Fernández Islands, Chile).

HOLOTYPE: USNM 164227. A dried specimen 92 mm. in standard length, taken in lobster traps in February 1955 off Más a Tierra Island, Juan Fernández Islands, off the coast of Chile, at depth of 200 to 250 meters by fishermen.

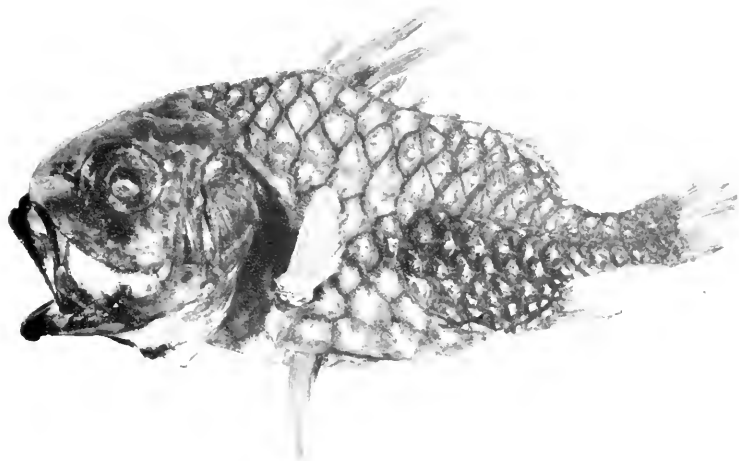
DESCRIPTION: The following counts were made: Dorsal rays VI,ii,10, with a rudiment of a seventh spine; anal i,10; pectoral ii;12-ii,12; pelvic I,iii; plates along lateral line from rear of head to base of caudal fin 18 on one side, 19 on the other; plates in a row from soft dorsal origin to lateral line 4, and from anal origin to lateral line (obliquely forward) 4. The details of arrangement of plates are illustrated in the photographs.

Certain measurements were made on the holotype, and these are expressed in thousandths of the standard length of 92 mm. as follows: Length of head 392; greatest depth 456; least depth of caudal peduncle 92; length of caudal peduncle from base of last anal ray to midbase of caudal fin 174; diameter of eye 130; length of snout 125; maxillaries or distance from tip of snout to rear of maxillary 201; bony interorbital space 120; length of first dorsal spine 102, of longest or second dorsal spine 267; length of pelvic spine 310.

See table 1 for counts made on *Monocentris japonicus* (Houttuyn) and *M. reedi*, new species.

DISCUSSION: The family Monocentridae has referred to it two genera—*Monocentris* Bloch and Schneider with *Gasterosteus japonicus* Houttuyn as genotype, from the western Pacific, and *Cleidopus* De Vis with *C. gloria-maris* De Vis as genotype, from Australia. The genus *Cleidopus* differs from *Monocentris* in having a patch of vomerine teeth, a luminous organ on each side of the mandible, a very narrow preorbital bone instead of no teeth on the vomer, no luminous organ on the mandible, and a broad preorbital bone.

Powell (Rec. Auckland Inst. Mus., vol. 2, p. 151, pl. 36, 1938, type locality Opoutama Beach, 40 miles south of Gisborne, New Zealand) described *Cleidopus neozelandicus*. He points out that this species is intermediate between *Monocentris* and *Cleidopus*. It agrees with *Monocentris* in having a broad preorbital and no luminous organs on mandible. It agrees with *Cleidopus* in having vomerine teeth. With this intermediate species, perhaps as Powell suggests, *Cleidopus* should be referred as a synonym to *Monocentris*. Anyway, regardless of the generic affinities which I cannot work out because of lack of material, *neozelandicus* differs from *reedi* in having vomerine teeth, a



Holotype of *Monocentris reedi*, new species.





deeper body, and greatest depth 1.6 for *neozelanicus* and 2.1 or 2.2 for *reedi*.

The genus *Monocentris* has had up to the present only one species referred to it, namely *M. japonicus* (Houttuyn). The following named species are synonyms of *japonicus*: *Sciæna japonica* (*cataphracta*) Thunberg and *Monocentris carinata* Bloch and Schneider.

TABLE 1.—Counts recorded for species of *Monocentris*

Species	Number of fin rays												
	Dorsal fin						Anal fin soft rays		All rays of pectoral fin				
	Spines			Soft rays									
	V	VI	VII	11	12	10	11	12	13				
<i>M. japonicus</i> (Houttuyn).....	1	7	3	10	1	9	2	13	8				
<i>M. reedi</i> , new species.....		1			1		1	2					
	Number of gillrakers on first arch								Total number of gillrakers on first arch				
	Above angle		At angle	Below angle									
	7	8	1	12	13	14	15	16	20	21	22	23	24
	<i>M. japonicus</i> (Houttuyn).....	6	4	10	6	3	1			5	2	2	1
<i>M. reedi</i> , new species.....		2	2					2					2
	Number of plates along lateral line												
	14		15		16		17		18		19		
	<i>M. japonicus</i> (Houttuyn).....	1		6									
<i>M. reedi</i> , new species.....									1		1		

*Monocentris japonicus* differs from *M. reedi* in having a deeper body, 1.6 to 1.8 instead of 2.1 to 2.2; gillrakers 12 to 14 on lower part of first gill arch instead of 16; and 14 or 15 plates along lateral line instead of 18 or 19. In addition *M. reedi* appears to have a more slender caudal peduncle than *M. japonicus*. Because of the dried condition of the type and the tips of all soft fin rays having been broken off, it is not possible to compare with accuracy many possible measurements. When more specimens become available a more detailed study is needed, but this short description brings to the attention of ichthyologists a remarkable discovery in the eastern Pacific.

I take great pleasure in naming this rare species in honor of Dr. Edwyn P. Reed, who brought it to my attention and who deposited the holotype in the U. S. National Museum.



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EMENDED DESCRIPTION AND ASSIGNMENT TO THE NEW  
GENUS RONALEA OF THE IDOTHEID ISOPOD  
*ERICHSONELLA PSEUDOCULATA* BOONE

By ROBERT J. MENZIES and THOMAS E. BOWMAN

In 1923 Boone described a new species of idotheid isopod from San Pedro, Calif., under the name *Erichsonella pseudoculata*. Boone's single specimen was a male. More recently a second specimen, this time a female, was collected from *Phyllospadix* at La Jolla, Calif. In all known species of *Erichsonella* the abdomen is unisegmental, without partial sutures at the base. Boone's species, although otherwise fitting nicely into *Erichsonella*, has partial sutures at the base of the abdomen. We are therefore faced with the alternatives of expanding the definition of *Erichsonella* or erecting a new genus for *pseudoculata*. Since the number of partial or complete sutures at the abdominal base appears to be constant at the generic level in idotheid isopods, we have elected to establish a new genus, *Ronalea*, for Boone's species.

In the genus *Eusymmerus* Richardson (1889, p. 852) the abdomen also has one partial suture at its base, but it differs from the new genus in that the coxal plates, visible in dorsal view, are separated only in pereion segments 6 and 7. In *Ronalea* the coxal plates are separated in pereion segments 2-7 as in *Erichsonella*, but are visible in dorsal view only in segments 5-7. Moreover, the general body

conformation of *Eusymmerus*, with the evenly rounded lateral margins of the pereion and pleon, stands in contrast to the irregular nature of these margins in the narrower and less dorsoventrally flattened *Ronalea* and *Erichsonella*.

Boone's description, although detailed, contains a few misleading statements. Although it was stated in her paper that her *Erichsonella pseudoculata* and other isopods described therein would "be more fully discussed and illustrated in a forthcoming monograph," this monograph has not appeared. We are therefore providing illustrations of taxonomically important details and an emended description of Boone's species.

### ***Ronalea*, new genus**

DIAGNOSIS: Body narrow; lateral margins of pereion and pleon irregular. Flagellum of antenna 2 uniaarticulate. Palp of maxilliped composed of four segments. Coxal plates distinct from the segments in pereion segments 2-7, visible dorsally in segments 5-7. Abdomen composed of a single segment with a pair of incomplete lateral sutures at the base. Type species, *R. pseudoculata* (Boone).

### ***Ronalea pseudoculata* (Boone), new combination**

*Erichsonella pseudoculata* Boone, 1923, pp. 154-155.

MALE HOLOTYPE: Length 8.2 mm., greatest width at level of pereionite 1, 2.5 mm., USNM 50420.

FEMALE: Oostegites fully developed, length 9.0 mm., greatest width at level of pereionites 3-4, 2.5 mm.

HEAD: Frontal lamina conical, reaching level of distal end of first segment of antenna 1, tip evenly rounded in female, somewhat obtuse in male. Median frontal margin almost straight. Middle portions of lateral margins produced into rounded lobes, in which the swollen eyes are situated. Dorsum with a conspicuous median bifid tubercle projecting anteriorly over the frontal margin.

PEREION: Somites without supralateral projections. First somite with anterolateral angles produced into bilobed processes; in the male two pigmented oval areas are present on the lateral parts of the dorsum, hence the specific name given by Boone. Lateral margins of somites 2-5 concave, of somites 6-7 evenly rounded. Each somite with carina on middorsal line; that of somite 1 divided and occupying the length of the somite; those of somites 2-7 single and located near the posterior margins; carinae much more conspicuous in the male. Epimeral plates distinct from pleura in somites 2-7, visible dorsally in somites 5-7; that of somite 5, seen dorsally, quite small and occupying a portion of the middle of the lateral margin; those of somites 6 and 7 well developed and occupying the posterior halves of their somites.

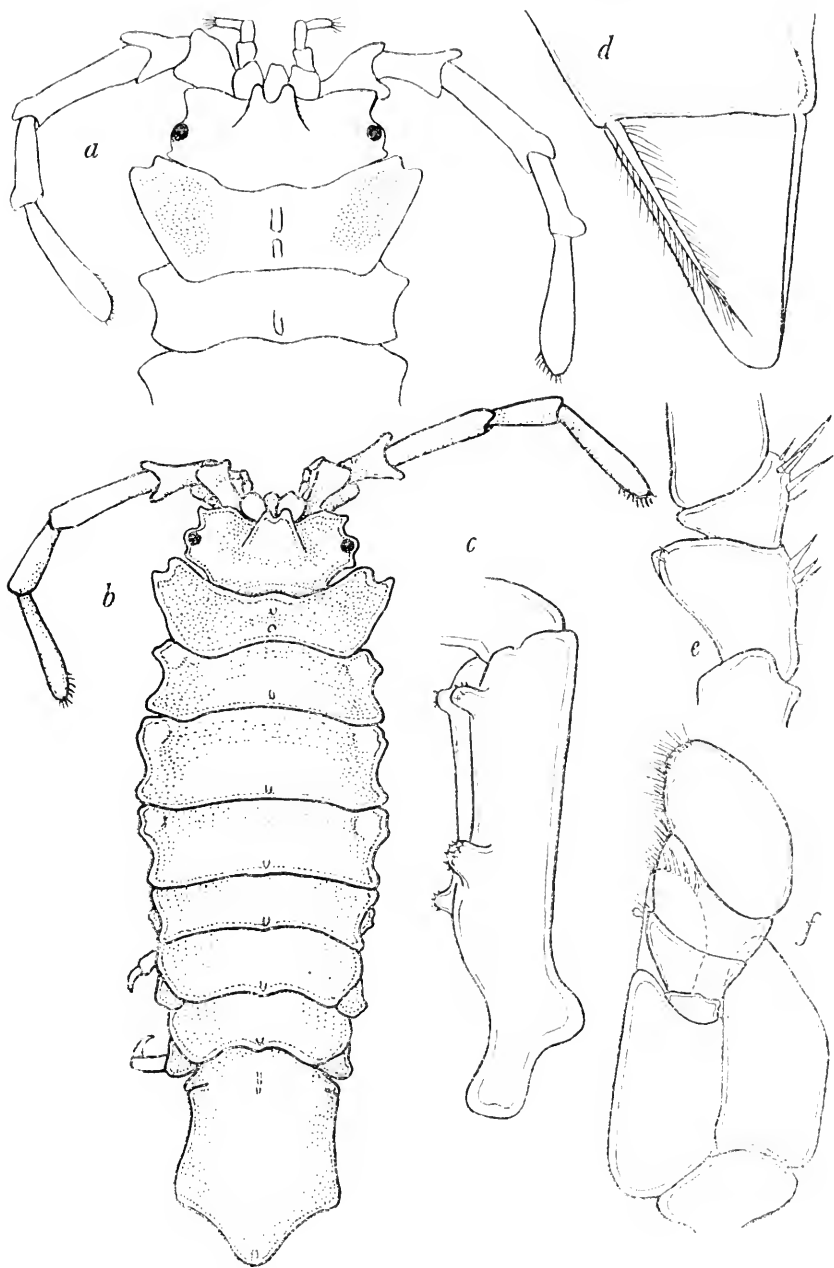


FIGURE 1.—*Ronalea pseudoculata* (Boone): *a*, male holotype, anterior part of body, dorsal view; *b-f*, female: *b*, dorsal view; *c*, basis of pereopod 7; *d*, left uropod, apical segment, inner surface; *e*, pereopod 1, merus, and carpus; *f*, maxilliped.

**PLEOTELSON:** Composed of a single somite, with lateral incisions partially separating a second somite at the base. Greatest width between the posterolateral angles about three-fourths the length. Posterior end terminating in a rounded apex, with concave lateral margins. Central portion of dorsum elevated into a ridge decreasing in height posteriorly. In the male three slight but distinct tubercles are present on this ridge at the base; only the faintest indications of these tubercles are found in the female. Uropod with triangular apical segment, peduncle grooved along free lateral margin and bearing a single plumose seta at distomedial angle.

**APPENDAGES:** Antenna 1: Composed of four short segments, not five as stated by Boone; first segment very plump, slightly shorter than second and third combined; flagellum bearing a group of filamentous setae at the distal end.

Antenna 2: Slightly longer than half the length of the body. Peduncle composed of five segments, distal ends of segments 2-4 flaring widely. Flagellum about as long as peduncle segment 4, bearing distally a number of filamentous setae.

Mandible: Molar process with edges divided into a few blunt teeth; setal mass formed of densely clumped setae, some very long. Incisor with five teeth; lacinia mobilis with three teeth. Setal row formed of six spinulate setae.

Maxilla 1: Outer lobe bearing 13 stout setae and a single slender plumose seta at the apex.

Maxilla 2: Composed of two lappets; outer lappet bilobed, bearing seven and six comblike setae on the outer and inner lobes respectively; inner lappet with 10 setae at the apex.

Maxilliped: Palp of four segments; endognath with a single coupling hook.

Pereiopods: Dactyls biunguiculate. Pereiopod 1 bearing a single row of about 10 comblike setae on medial surface of propodus near posterior margin. Basipods of pereiopods 2-7 bearing two pairs of bosses armed with short spines.

**PENIS:** Consists of two plates, concealed by the uropods.

**COLOR:** After 38 years in alcohol, the male is without pigmentation except in the eyes and in the previously mentioned areas of perion somite 1, which Boone called "false eyes." The female is pigmented more or less uniformly brownish black (in alcohol) over the entire dorsal surface; no "false eyes" are evident.

**LOCALITIES:** The holotype was collected by E. P. Chace on Oct. 17, 1917, at San Pedro, Calif., from near the foot of the breakwater. The female was collected by R. J. Menzies on Aug. 2, 1942, at La Jolla, Calif., from eel grass (*Phyllospadix*).

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# PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM



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## OBSERVATIONS ON THE AMPHIPOD GENUS *PARHYALE*

BY CLARENCE R. SHOEMAKER

The genus *Parhyale* was created by T. R. R. Stebbing in 1897 for an amphipod taken at St. Thomas, Virgin Islands, because it differed from *Hyale* by the possession of a minute inner ramus to the third uropod, a character which had not been noted in any member of the Talitridae. This inner ramus having been overlooked by all students of the Amphipoda, the species of *Parhyale* had been assigned to *Hyale* or *Allorchestes*. Stebbing described and figured the species *Parhyale fasciger* (later changing the name to *fascigera*) from St. Thomas, Virgin Islands. In 1853 James D. Dana described a species *Allorchestes hawaiiensis* from Maui, Hawaiian Islands, and figured it in 1855. He did not, however, describe or figure the small inner ramus to the third uropod which this species possesses. Stebbing (1906, p. 573) transferred Dana's species to *Hyale*, but gave it doubtful specific status. Dr. A. Schellenberg (1938, p. 66) correctly identified specimens of this species from Hawaii, but continued to place the species in *Hyale*.

*Parhyale kurilensis* was described by Masao Iwasa (1934, p. 1) from specimens taken in the Kurile Islands. A. N. Derjavin (1937, p. 106) made Iwasa's species a synonym of Brandt's species *Allorchestes ochotensis*, which was made the genotype of a new genus *Parallorchestes* by Shoemaker (1941, p. 183). Derjavin at the same time transferred Brandt's species to *Parhyale*, making it *Parhyale*

*ochotensis*. *Parhyale zibellina* described by Derjavin (1937, p. 109) from the Soviet coast of the Sea of Japan appears to belong to the genus *Parallorchestes*.

The genus *Hyaloides* created by Schellenberg (1939, p. 126) for specimens from Banana, Belgian Congo, differs from *Parhyale* only by the lobe of the fifth joint of the second gnathopod of the male. As this lobe is present only in the males of *Parhyale fascigera* and *P. hawaiiensis* which are not fully mature, and is entirely lost in the fully mature males, *Hyaloides* becomes a synonym of *Parhyale*. This lobe is present also in the not fully mature males of many species of *Hyale*, but is lost by full maturity.

The following combination of characters separates *Parhyale* from *Hyale*: Antenna 1 reaching well beyond the peduncle of antenna 2; antenna 2 rather long with many-jointed flagellum; maxilliped with a dense brush of spines or setae at the apex of the third joint of the palp. Uropod 3 with small inner ramus; telson cleft to base; seventh joint of all pereopods short, curved only at the nail, and bearing a stout seta on inner margin. The female is like the male except in the gnathopods, which are slender and weaker.

Up to the present time two species of *Parhyale* have been described, *P. fascigera* Stebbing and *P. hawaiiensis* (Dana). They are widely distributed in the warmer waters of the bays and estuaries of the globe, and have been described at times as species of *Hyale*.

#### *Parhyale fascigera* Stebbing

FIGURES 1, 2, a-f

*Parhyale fasciger* Stebbing 1897, p. 26, pl. 6.

*Parhyale fascigera* Stebbing 1906, p. 556.

*Hyale brevipes* Shoemaker 1933, p. 18, figs. 10, 11.

*Hyale hawaiiensis* Shoemaker 1942, p. 18.

Stebbing's description and figures are good, though they appear to be of somewhat smaller specimens than have been used for the present description and figures.

MALE: Head nearly as long as the first two body segments combined. Eye more or less pyriform, and dark brown in alcohol. Antenna 1: Reaching well beyond the peduncle of antenna 2; flagellum much longer than peduncle and composed of from 11 to 15 joints. Antenna 2: Nearly half as long as the body; fourth and fifth peduncular joints nearly equal in length; flagellum about twice as long as the peduncle and composed of from 15 to 24 joints.

Mandible with well-developed molar and toothed cutting edge; spine-row of five or six spines and several plumose setae. Maxilla 1: With rather slender inner plate bearing two apical plumose setae;

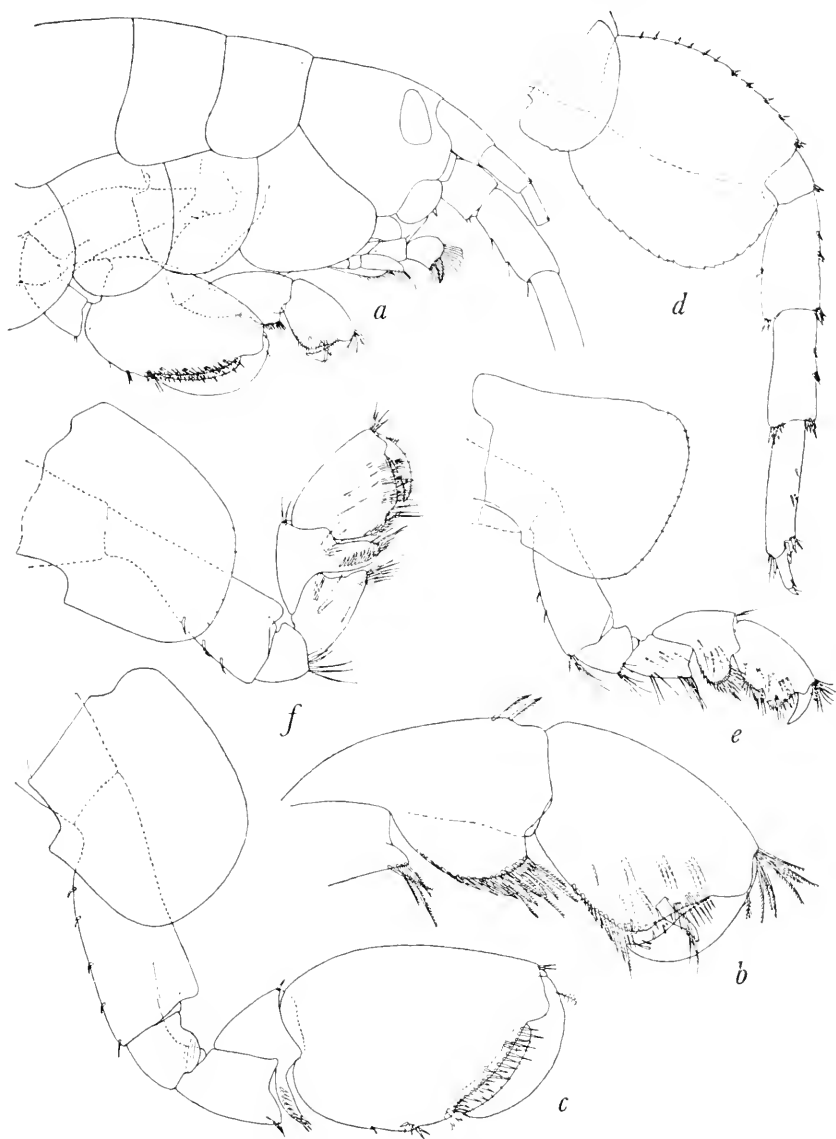


Figure 1.—*Parhyale fascigera* Stebbing. *a-f*. Male from Martinique, West Indies: *a*, front end of animal; *b*, end of gnathopod 1, much enlarged; *c*, gnathopod 2, immature; *d*, peraeopod 5. *e,f*, Female from Martinique, West Indies: *e*, gnathopod 1; *f*, gnathopod 2.

outer plate armed with nine serrate spine-teeth; palp not reaching end of outer plate and bearing one apical plumose seta. Maxilla 2: Inner plate shorter than the outer and both well armed distally with long slender spines. Maxilliped: Inner plate rather long, reaching to the middle of the outer plate, and armed distally with three teeth and the usual plumose spines or setae; outer plate shorter than the inner, reaching to the middle of the second joint of the palp and armed on the inner margin and rounding extremity with submarginal spines; palp short and stout, second and third joints widened distally by a lobe on the upper inner margin; fourth joint stout, bearing a row of short spinules on inner margin and a sharp apical nail. The third joint of palp bears distally a dense brush of setae which is characteristic of the genus.

Gnathopod 1: Rather stout and strong, second joint widening greatly toward the middle, without lower front lobe, and having several downward-curving spines on the hind margin; fourth joint about three-fourths as long as the fifth, and with lower front corner acute; fifth joint about as long and wide as the sixth, and with a broad rounding lobe below bearing a row of stout spines; sixth joint longer than wide, widest at the palmar angle, and bearing a row of forward-pointing spines on the distal hind margin; palm oblique, nearly straight, armed throughout with short spines, bearing a stout spine on the outside near the middle and a smaller spine on the inside below the defining angle; on the rounding defining angle is a slightly raised curved area thickly studded with fine rasplike teeth upon which the end of the seventh joint rests (fig. 2,a); seventh joint stout, aquiline, fitting palm, and bearing a row of spinules on inner margin.

Gnathopod 2: Much larger and stronger than 1, second joint not much expanded, lower front corner roundly quadrate, but not produced downward, and hind margin bearing a few short downward-curving spines; third, fourth, fifth, and sixth joints as shown in fig. 2,b; fifth joint without lower lobe in fully mature males; sixth joint broadly oval, hind margin about as long as palm and bearing one or two groups of short spinules; palm very oblique, slightly convex, armed throughout with short spines, and defined by a slight protuberance on the inside of which is a shallow depression or pocket bearing two or three short spines; seventh joint rather strong, fitting palm with the apex resting in the shallow pocket on the inside of the defining angle (fig. 2,b). In the younger or not fully mature males the fifth joint of gnathopod 2 is produced into a narrow curving lobe between the fourth and sixth joints (fig. 1,c).

Peracopods 1 and 2 are alike in structure, but 2 a little the shorter (fig. 2,c). Peracopod 3 about equal in length to peracopod 1. Peracopods 3 to 5 much alike in structure, but 4 may be a little longer than

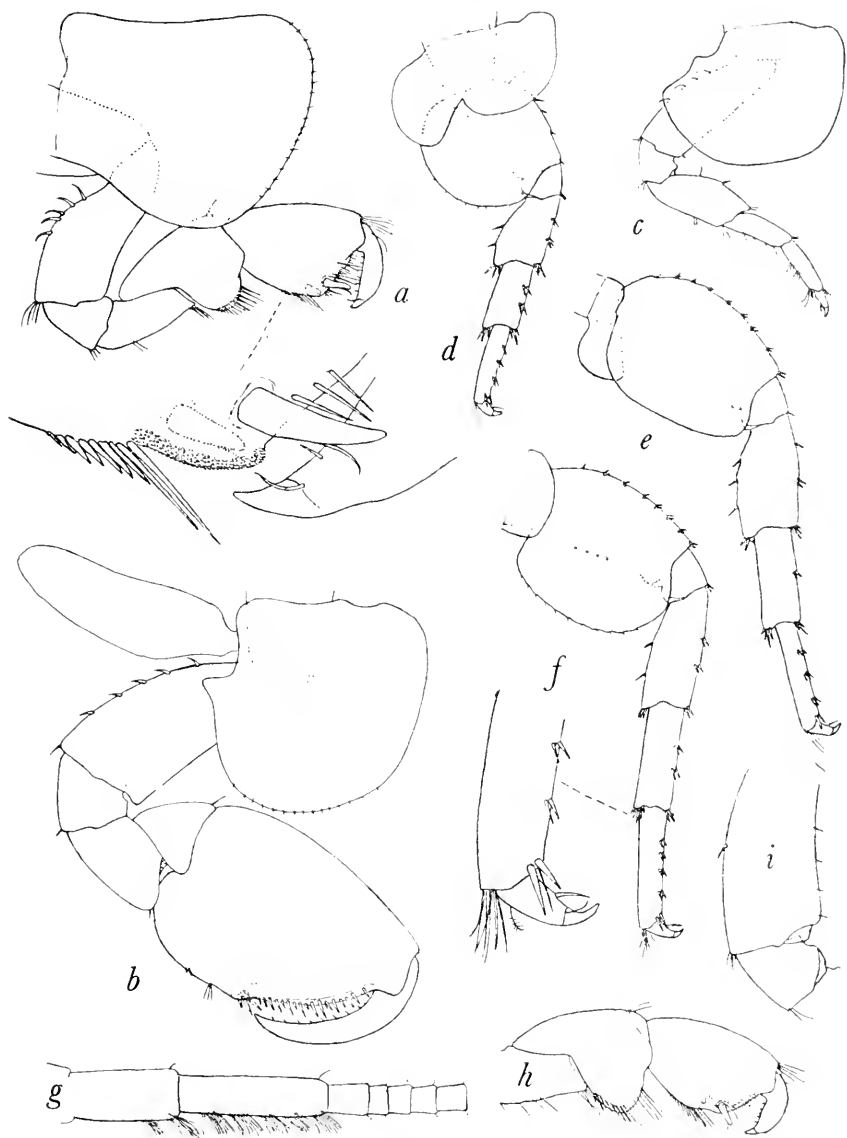


Figure 2.—a-f, *Parhyale fascigera* Stebbing, male from St. Croix, Virgin Islands: a, Gnathopod 1; b, gnathopod 2; c, pereopod 2; d, pereopod 3; e, pereopod 4; f, pereopod 5. g-i, *Parhyale fascigera penicillata*, new subspecies, male: g, antenna 2; h, gnathopod 1; i, second and third joints of gnathopod 2.

5 (fig. 2,*d-f*). The hind margin of the sixth joint of peraeopods 3 to 5 does not bear spines except at the distal end.

Metasome segments 2 and 3 with lower hind corner quadrate, or a little less than a right angle in some specimens. Uropod 1 projects farther back than 2, and 2 farther than 3. Uropod 1: Peduncle a little longer than the subequal rami, armed on upper outer margin with three or four spines and an apical stouter spine; outer ramus without marginal spines but armed apically with one long and several shorter spines; inner ramus with three or four marginal spines and several apical spines. Uropod 2: Outer ramus without marginal spines, but with apical spines; inner ramus with two marginal spines and apical spines. Uropod 3: Very short, peduncle not extending beyond the telson and about equal in length to the outer ramus which bears only terminal spines; inner ramus very small and as shown for that of *P. hawaiiensis* (fig. 4,*n*).

The gills are simple. The small vesicle accompanying the gills of the second gnathopod and those of the first four peraeopods referred to by Stebbing (1897, p. 26) could not be found. Stebbing says, "The skin has some minute setules scattered over it," but these could not be found in any of the specimens studied.

Males from the West Indies measure about 9 mm. from the front of the head to the end of the uropods. Males from the Galápagos Islands measure 10.5 mm.

FEMALE: The female is much like the male, but with the differences usual in the closely related genus *Hyale*. The antennae are shorter, and the gnathopods are smaller and weaker (fig. 1,*e,f*). The marsupial plates are like those of *P. hawaiiensis* (fig. 4,*r*).

In the collection of the U. S. National Museum there are specimens of *P. fascigera* from Florida; Texas; Jamaica; Haiti; Puerto Rico; St. Croix; Dominica; Martinique; Venezuela; Curaçao; and Sabanilla, Colombia; and, from the Pacific, west coast of México; Perú; Juan Fernández Islands; and Galápagos Islands.

*Parhyale fascigera penicillata*, new subspecies

FIGURE 2,*g-i*

This subspecies is much like *P. fascigera*. Antenna 2 of the male carries two groups of plumose setae on the lower distal end of the fourth joint, and five groups on the lower margin of the fifth joint (fig. 2,*g*). The sixth joint of the first gnathopod of the male is narrower than in typical *fascigera*, and the large palmar spine is at the defining curve; the seventh joint is short. The second joint of the second gnathopod of the male is without a lobe at the lower front



corner. In uropods 1 and 2 the outer ramus is without lateral spines, but has terminal spines.

The female does not have the groups of plumose setae on the lower margin of the fourth and fifth joints of the peduncle of the second antenna.

A number of specimens were taken in La Paz Bay, Lower California, on May 2, 1921, by L. G. Rubio.

TYPE: A male, USNM 96983, taken in La Paz Bay, Lower California, March 2, 1921, by L. G. Rubio.

*Parhyale hawaiiensis* (Dana)

FIGURES 3, 4

*Allorchestes hawaiiensis* Dana 1853 and 1855, p. 900, pl. 61, figs. 5a-h.

*Hyale brevipes* Chevreux 1901, p. 400, figs. 15-18.

*Hyale hawaiiensis* Stebbing 1906, p. 573.

*Hyale trifoliadens* Kunkel 1910, p. 72, fig. 27.

*Hyale inyacka* Barnard 1916, p. 233, pl. 28, fig. 4.

*Hyale hawaiiensis* Schellenberg 1938, p. 66, fig. 34.

*Hyaloides dartvellei* Schellenberg 1939, p. 126, figs. 6-10.

*Parhyale hawaiiensis* is very much like *P. fascigera*, but the differences though slight are definite. *P. hawaiiensis* is more spinose than *P. fascigera*.

MALE: Head not as long as the first two body segments combined. Eye pyriform and light brown in alcohol. Antennae are about the same proportions as in *P. fascigera* (fig. 3,a); flagellum of antenna 1 with 15 to 17 joints, and that of antenna 2 with 24 to 29 joints. The mouthparts are like those of *P. fascigera* and are as shown by figures 3,b-f. Some of the most distinguishing characters are in the gnathopods.

Gnathopod 1: Second joint not quite so much expanded as in *P. fascigera*; the sixth joint is rather oval and not so suggestive of a triangle; the large spine of the palm of *P. fascigera* is not present, but is replaced by a smaller spine which is nearer the hind margin of the joint; the spine on the inner side of the defining angle has moved down to the middle of the hind margin of the joint; the raised rasping portion of the defining angle is absent, but the minute rasping teeth are present on the hind margin of the joint just below the defining spine (fig. 4,b); the seventh joint fitting palm and more or less quiline as in *P. fascigera*.

Gnathopod 2: Second joint not much expanded, but the lower front corner is produced into a narrow downward-pointing lobe which is very characteristic of this species, as it is present also in the second gnathopod of the female (figs. 3,h and 4,r); the front margin of the joint bears a few minute spinules and the hind margin bears several

short downward-curving spines; the following joints are like those of *P. fascigera*, and are as shown in figure 3,*h*.

Peraeopods 1 and 2 much alike but 2 is a little the shorter (figs. 3,*i* and 4,*d*). Peraeopod 3: About as long as peraeopod 2, second joint much expanded, being as wide as long; fourth joint not much expanded and little produced downward behind; fifth and sixth joints about equal in length; the front margin of all joints bearing groups of spines (fig. 3,*j*). Peraeopod 4: Considerably longer than 3, and a little shorter than 5; second joint not as much expanded as either that of 3 or 5, hind margin nearly straight, and with very shallow hind lobe; fourth joint not much expanded and not produced downward behind; fifth joint a little shorter than the sixth (figs. 3,*k* and 4,*g*). Peraeopod 5: Second joint much expanded, being as wide as long; fourth joint scarcely at all expanded; fifth joint a little shorter than the sixth. Both front and hind margin of sixth joint of peraeopods 4 and 5 with groups of spines (fig. 4,*g,j*). The seventh joint of all peraeopods is short and nearly straight except for the rather sharply upward-curving nail (fig. 4,*e,f,j*). This dactyl is very characteristic of *P. fascigera* and *P. hawaiiensis*. All peraeopods are rather short, as was noticed by Chevreux when he described *Hyale brevipes* from the Sechelles Islands.

Metasome segments 2 and 3 with lower hind corner about quadrate or less than a right angle and not produced. Urosome segments 2 and 3 very narrow, not showing at all dorsally. Uropod 1 extending back farther than 2, and 2 farther than 3. Uropod 1: Peduncle longer than rami; upper outer margin bearing four to six spines besides the stout terminal spine, inner margin with about four spines; rami subequal in length, outer ramus with one to three marginal spines and a terminal group; inner ramus with spine arrangement same as that of outer ramus. Uropod 2: Peduncle equal to or a little longer than the rami, the outer of which is perhaps a little the shorter; peduncle with a few marginal spines; outer ramus with one or two marginal spines and a group of terminal spines; inner ramus with two or three marginal spines and terminal group. Uropod 3: Peduncle about equal in length to the outer ramus and reaching to about the end of the telson (figs. 4,*k,n*), inner ramus very small and bearing an apical spinule (fig. 4,*n*). Telson cleft to base with lobes widely gaping (fig. 3,*n*).

Coxal plate 1 is expanded below and produced forward as shown in figure 4,*a*. Coxal plates 2 to 4 are broadly and evenly rounding below. The gills of gnathopod 2 and those of peraeopods 1 to 4 are simple, as are those of *P. fascigera*. *P. hawaiiensis* does not have minute setules scattered over the body integument which are said by

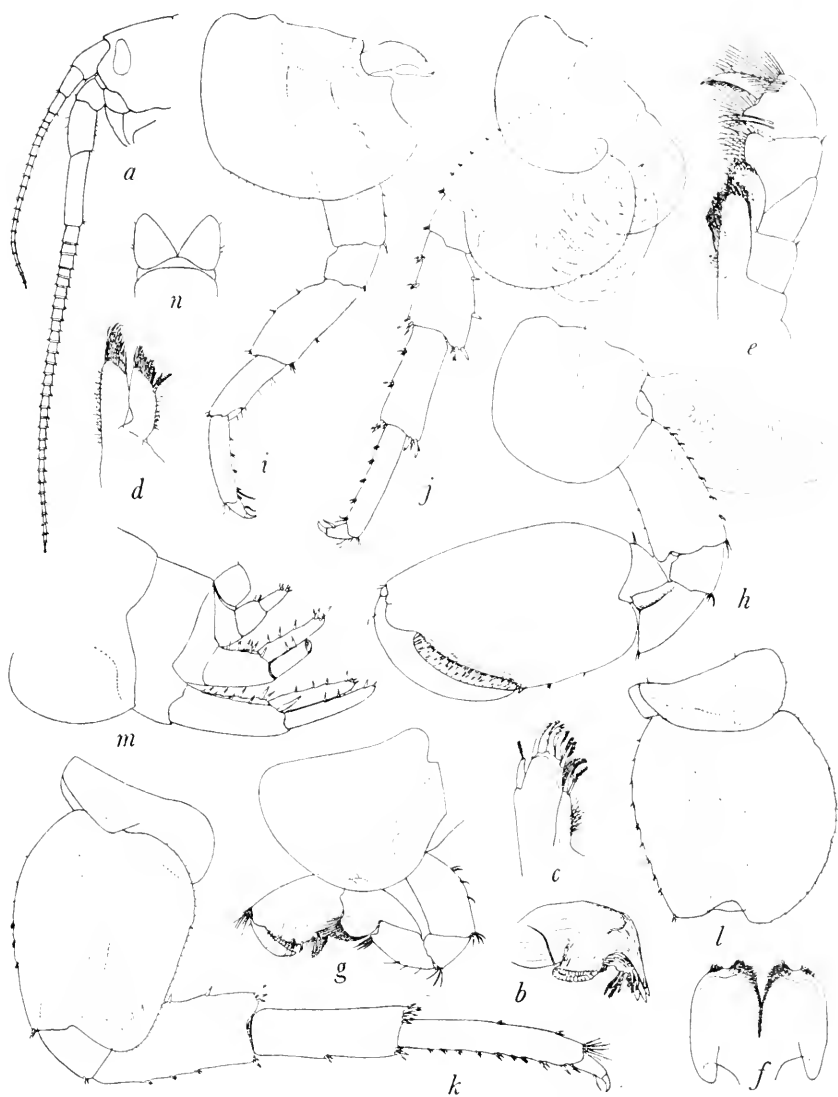


Figure 3.—*Parhyale hawaiiensis* (Dana), male from Fort Jefferson, Tortugas, Fla.: *a*, head and antennae; *b*, mandible; *c*, maxilla 1; *d*, maxilla 2; *e*, right maxilliped; *f*, lower lip; *g*, gnathopod 1; *h*, gnathopod 2; *i*, peraeopod 2; *j*, peraeopod 3; *k*, peraeopod 4; *l*, peraeopod 5; *m*, rear end of animal; *n*, telson.

Stebbing to be present in *P. faseigera*. Males from Ecuador reach a length of 11 mm., and males from Fort Jefferson, Tortugas, Fla., 12 mm.

FEMALE: The female is much like the male except in the gnathopods. Gnathopod 1: More slender than in the male; second joint about as long as the fifth and sixth joints combined and with a small rounding lobe on the lower front margin; fifth joint shorter than sixth, with a rounding lower lobe; sixth joint not quite twice as long as wide, hind margin with a row of spines; palm not as oblique as in the male, convex, with a row of four or five curved spines interspersed with more numerous shorter spines, below which are four or five groups of long spines, defining angle evenly rounding with a stout spine on the outside and one on the inside, and bearing a very few of the minute rasping teeth like those of the male; seventh joint not so aquiline as in the male, fitting palm, bearing three spinules on the inner margin and two longer ones near apex (fig. 4, *o, p*).

Gnathopod 2: Stouter than 1; second joint equal in length to the fifth and sixth joints combined, widening distally with the lower front margin produced downward into a more or less triangular lobe, which is somewhat more prominent than that of the second gnathopod of the male; fourth joint produced forward below; fifth joint about two-thirds as long as sixth; sixth joint about one-third longer than wide and widest in the middle, hind margin about as long as palm, slightly bulging in the middle and bearing a row of long spines; palm quite oblique, slightly convex, armed with four or five curved spines and a row of more numerous shorter spines below which are five groups of long spines, defined by two stout spines, and merging into the hind margin by an evenly rounding curve; seventh joint fitting palm and bearing six spinules on inner margin and two or three longer ones near the apex.

The marsupial plates are drawn out into a long narrow apex and densely fringed with rather short setae (fig. 4, *r*). Cheveux (1901, p. 401, fig. 17) shows this character for *Hyale brevipes*.

Females from Hawaii measure 7 mm.; those from the Galápagos Islands, 8.5 mm.

As all of Dana's types have been destroyed, a neotype is here being designated.

NEOTYPE: A male, USNM 96984, from the Waikiki Marine Laboratory, Honolulu, Hawaii, taken by G. S. Mansfield on Apr. 24, 1942.

There has been considerable confusion as to the status of these two species of *Parhyale*. Dr. K. Stephensen (1948, p. 6) appears to have been the first to have noted the characters which distinguish

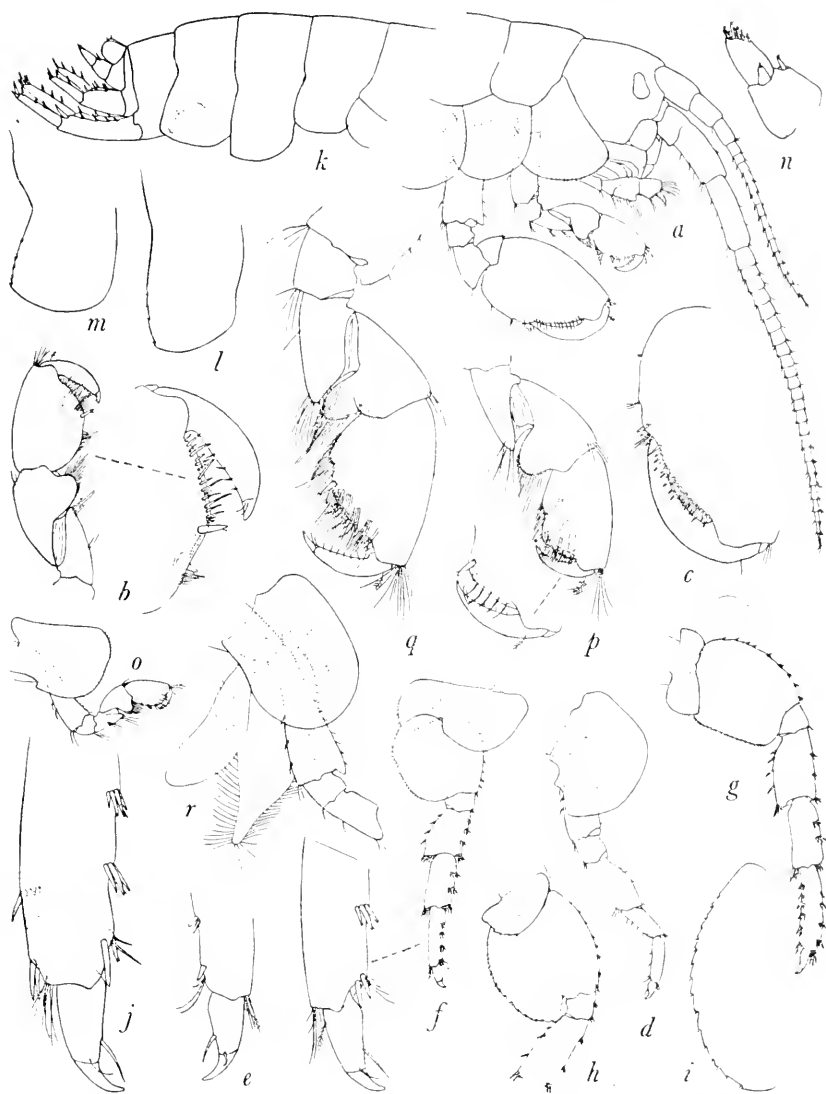


Figure 4.—*Parhyale hawaiiensis* (Dana) from Johnston Island, Oceanica. Male, *a-n*: *a*, front end of animal; *b*, gnathopod 1; *c*, gnathopod 2; *d*, peraeopod 2; *e*, seventh joint of peraeopod 2; *f*, peraeopod 3; *g*, peraeopod 4; *h*, peraeopod 5; *i*, rear margin of second joint of peraeopod 5; *j*, end of sixth joint and seventh joint of peraeopod 5; *k*, rear end of animal; *l*, *m*, second and third metasome segments; *n*, telson. Female, *o-r*: *o*, gnathopod 1; *p*, end of gnathopod 1 enlarged; *q*, gnathopod 2; *r*, gnathopod 2 showing marsupial plate.

them. He, however, did not know that *Hyale inyacka* Barnard was a synonym of *Parhyale hawaiiensis* (Dana), as he had never seen the latter species.

The literature has been examined and in many cases it has been impossible to determine which of these two species is being dealt with, as the distinguishing characters have not been mentioned or figured. The following identifications should have been *P. fascigera*: *Hyale brevipes*, Shoemaker (1933, p. 18, figs. 10–11); *Hyale hawaiiensis*, Shoemaker (1942, p. 18).

The following identifications should have been *P. hawaiiensis*: *Hyale aquilina*, Della Valle (1893, p. 523, pl. 16, figs. 43–47); *Hyale brevipes*, Chevreux (1901, p. 400, figs. 15–18); *Hyale nilssoni*, Walker (1905, p. 925, figs. 140–1); *Hyale prevostii*, Kunkel (1910, p. 66, fig. 25); *Hyale pontica*, Kunkel (1910, p. 69, fig. 26); *Allorchestes aquilina*, Chevreux (1911, p. 240, pl. 16, figs. 20–25); *Hyale prevostii*, Shoemaker (1920, p. 378); *Hyale brevipes*, Chilton (1921, p. 545, fig. 9♀); *Hyale inyacka*, Chevreux (1925, p. 370, fig. 17); *Hyale inyacka*, Stephensen (1933, p. 441, figs. 3, 4); *Parhyale fasciger*, Fage and Monod (1936, p. 105); *Parhyale inyacka*, Barnard (1940, p. 472); *Parhyale inyacka*, Stephensen (1948, p. 6); *Hyale hawaiiensis*, Ruffo (1950, p. 57).

In the collection of the U. S. National Museum there are specimens of *Parhyale hawaiiensis* from: ATLANTIC OCEAN: Curaçao; Bonaire; Venezuela; Brazil; Dominica; St. Croix; Puerto Rico; Haiti; Colombia; Texas; Florida; North Carolina; Bermuda; and Belgian Congo. PACIFIC OCEAN: Lower California; Costa Rica; Panamá; Ecuador; Hawaii; Galápagos Island; Johnston Island, Oceanica; New South Wales; and India.

REMARKS: *Amphithoe aquilina* Costa (1857, p. 202, pl. 2, fig. 7) was described from the Mediterranean, and transferred by Stebbing (1906, p. 565) to *Hyale*. Chevreux and Fage (1925, p. 289, figs. 300, 301) figured it and placed it in *Allorchestes* because of the lobe of the fifth joint of the second gnathopod of the male. Their figures are strongly suggestive of *Parhyale*: The gnathopods and first uropod are much like those of *P. hawaiiensis*, but the sixth joint of the fourth and fifth pereopods does not bear spines on hind margin, which would indicate *P. fascigera*, and the fifth joint of the second gnathopod of the male (fig. 301 gn 2 ♂) bears a narrow lower lobe, but their specimen may not have been fully mature. The third uropod does not show a second ramus, but it could easily have been overlooked.

*Hyale gracilis* Iwasa (1939, p. 282, text-fig. 19, pl. 19) is strongly suggestive of *Parhyale hawaiiensis*. James D. Dana (1853 and 1855) described and figured *Allorchestes gracilis* from Tongatabu, and Stebbing (1906, p. 572) transferred it to *Hyale*. Iwasa's name is therefore preoccupied, and I suggest the name *Hyale wasai* for it.

*Hyale stolzmanni* described by A. Wrzesniowski (1879, p. 201) from the coast of Perú is probably a synonym of *Parhyale hawaiiensis*, which species has been taken on the coast of Ecuador. He does not describe any of the essential characters and no figures are given, but his description, as far as it goes, applies to *Parhyale hawaiiensis*.

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A REVISION OF THE ACROCERID FLIES OF THE GENUS  
*PIALEA* ERICHSON WITH A DISCUSSION OF THEIR SEXUAL  
DIMORPHISM (DIPTERA)

By EVERT I. SCHLINGER<sup>1</sup>

While preparing a revision of the family Acroceridae (Cyrtidae) only five specimens of the genus *Pialea* were located for study, even though more than 6,000 specimens of the family had been borrowed from the various museums throughout the world. Because of the taxonomic confusion caused by the sexual dimorphic trait of this genus, and since specimens are apparently quite rare in collections and not often brought together for study, a revision of *Pialea* seems in order at this time.

I wish to acknowledge aid from the following people, who have contributed specimens and comments for this project: Prof. Max Beier of the Vienna Naturhistorische Museum, Austria; Prof. Willi Hennig of the Deutsches Entomologisches Institut, Berlin; Dr. S. L. Hora of the Zoological Survey of India in Calcutta, and Mr. Curtis W. Sabrosky, Entomology Research Branch, U. S. Department of Agriculture. Thanks are also due Dr. R. M. Bohart and Mr. Sabrosky for reviewing the manuscript. The drawings have been prepared by the author.

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The genus *Pialea* was described by Erichson (1840) for his new species *lomata* from Brazil. Westwood (1876) named a second species, *lutescens*, also from Brazil, but questioned its placement in *Pialea* because of the difference in the antennal insertion and slight differences in wing venation. Brunetti (1912) established the third species, *auripila*, from Burma, and (1926) a fourth species, *jardinei*, from Ceylon. Thus, four species have been described from four specimens of two different zoogeographical regions.

Hunter (1901) and Kertész (1909) listed *lutescens* as a synonym of *lomata* in their catalogs, and Brunetti (1912 p. 474) apparently followed them without question. How Hunter came to synonymize these species remains a mystery to me. Bezzi (1912, p. 78) attempted to show that these two species were distinct, basing his evidence on a male specimen from Brazil, which he determined as *lomata*.

I have been able to study the female type of *lomata*, the male type of *auripila*, and four other specimens representing the three new species herein described. An examination of the type of *auripila* revealed that it belongs to a new genus related to *Astomella* Lamarck. Judging from Brunetti's description of *jardinei*, I believe the species belongs to *Astomella*, rather than to the new genus to include *auripila*, which will be described in a later work. This transfer now leaves *Pialea* with only two known species, *lomata* and *lutescens*, both from Brazil.

#### SEXUAL DIMORPHISM

Sexual dimorphism of *Pialea* species is readily apparent only in the structure and insertion of the antennae, the longer wing length of the female, and in color patterns as in *ecuadorensis*, new species. Both color patterns and wing length are sexual differences occurring throughout the family, but I am unaware of this great antennal dimorphism in any other genus of Acroceridae and it may be considered unique for the family. The closely related genus, *Stenopialea* Speiser (1920, p. 205), may share this trait, but as yet only the male of its single species, *beckeri* Speiser, is known.

The sexual antennal dimorphism that has been studied in *Pialea* may be summarized as follows: Females have their antennae attached to the ventral surface of the antennal tubercle, and thus the antennae point downward throughout their length; the base of the first antennal segment is at or below the mideye height level; the antennal tubercle is typically smaller than in the males (fig. 3, *a-c*), and the first and third antennal segments are shorter and more conical or rounded than in the males. Males have their antennae attached to the anterior surface of the antennal tubercle and only the terminal segment points

downward, while the first two segments project straight forward; the antennal tubercle is large, nearly half as high as eye height, and is placed on the head so that its ventral surface is at or above the mid-eye height level (figs. 1,*b*, 3,*e*); the third antennal segment is longer and more laterally compressed than in the female, and the first segment is longer along its dorsal than its ventral surface.

Another character such as the longer abdomen of the male might also be noted and, if *ecuadorensis*, new species, is an indication, the color and maculation of the sexes may differ among the species of *Pialea*; however, this is more likely a specific rather than a generic character. One important and rather unique structure of the antennae, which is common to both sexes, is the whole or partial fusion of the first segment of each antenna into a common basal segment (figs. 3,*c,f,h,i*, 4,*f*). This latter feature is apparently shared by *Stenopialea beckeri* as deduced from the original description. Differences in antennal structure are frequently found between the sexes of species in the brachycerous Diptera, but I have been unable to find mention of any species exhibiting the significant difference of antennal insertion as described above.

#### SYSTEMATICS

The genus *Pialea* is in the subfamily Panopinae, and I believe it to be one of the more primitive genera of Acroceridae. It is more closely related to the still more primitive genus *Stenopialea* Speiser from South Africa than to its nearest South American relatives, *Pialeoidea* Westwood and *Ocnaea* Erichson. This would certainly suggest a definite relationship of the two faunas and a wider distribution of *Pialea* or *Stenopialea*, or both, sometime in the past.

It seems possible that *lutescens* Westwood and *antiqua*, new species, belong in a distinct genus, tending to fill the gap between *Pialea* and *Stenopialea*. However, for lack of sufficient material, these two species have been included in *Pialea*. Thus, the genus is redescribed below in its widest sense, and, should it be necessary to narrow its limits in the future, only three of the five known species—*capitella*, new species; *ecuadorensis*, new species; and *lomata* Erichson—would be included in typical *Pialea*.

#### Genus *Pialea* Erichson

*Pialea* Erichson, 1840, pp. 160-161, pl. 1, figs. 9, (9)p.

GENOTYPE: *Pialea lomata* Erichson (type by monotypy).

HEAD: Extremely small compared to thorax; eyes pilose, in lateral view covering anterior one-third to one-half of head capsule, well separated above and below antennae except in *P. capitella* (fig. 1,*e*); frontal region either with tubercle or somewhat raised; ocellar tubercle

raised, two lateral ocelli; antennae 3-segmented, segment I of each antenna fused basally or completely fused (fig. 3,c,h), short, attached to ventral surface (female) or anterior surface (male) of antennal tubercle, inserted well above (male), at, or below mideye height (female), segment II shorter than I, segment III long, with or without apical seta, round, or compressed, with concavity along outer margin, pointed or rounded apically; no visible palpi; proboscis minute, when visible not much longer than rounded, rigid proboscis tubercle in front; occiput narrow or wide; pile dense on occiput, eyes, dense or sparse on antennae; frontal region above and below antennae, occiput, proboscis plate, and lower part of sternopleura and meropleura grayish pollinose.

THORAX: Convex, strongly arched in front, leveled out behind, covered with dense pile except on lower sternopleura and meropleura, near base of halter, and on upper anterior side of postalar callosity; humeri separated by less than head width; squama large, narrow or wide; legs well built, tibiae with one (outer) or two (inner and outer) apical spurs, metatarsus extended (fig. 4,e) or compressed (fig. 4,g), three pulvilli, middle one narrowest; wing reaches beyond (female), at, or near tip of abdomen (male), rounded or angled at apex; venation strong; subcosta ends beyond middle of wing, no humeral crossvein,  $R_{2+3}$  incomplete or reaching wing margin, vein  $R_4$  ends at or before wing apex, no radial, cubital, or marginal veins reach wing margin behind  $R_4$  (except possibly in *lutescens*), and anal axillary vein short, usually not penetrating posterior lobe, four to six posterior cells, only the first and subdiscal ones closed, basal cells nearly even or second basal up to one-third longer, anal cell narrow or widened at apex.

ABDOMEN: Compressed dorsoventrally, widest at segment III or IV; six tergites and seven sternites easily visible; genitalia concealed under tergite VII, directed posteriorly, not ventrally; stigmata of at least segments II–IV free, lying in intersegmental membrane, each enclosed by small chitinous ring.

REMARKS: The first posterior cell is divided near the apex of the discal cell, and in this discussion I have interpreted the upper part as the first posterior cell and the lower part as the second posterior cell.

### Key to the species of *Pialea* Erichson

1. Antennae inserted on large tubercle both above mideye height level; wings not extending much beyond tip of abdomen [males]. . . . . 2  
     Antennae inserted on small (or large) tubercle, the antennae inserted at or below mideye height level; wings extending beyond tip of abdomen [females]. . . . . 4
2. Wing with vein  $R_{2+3}$  incomplete . . . . . 3  
     Wing with vein  $R_{2+3}$  complete (Brazil) . . . . . **P. lomata** Erichson

3. Wing with first and second basal cells of nearly equal length; eyes covering more than one-half of head capsule (Brazil) . . . **P. capitella**, new species  
Wing with second basal cell about one-third longer than first; eyes covering only one-third of head capsule (Ecuador) . . . **P. ecuadorensis**, new species
4. Wing with anal cell widened at apex, six posterior cells; antennae inserted on large tubercle . . . . . 5  
Wing with anal cell nearly of equal width throughout, four posterior cells; antennae inserted on slightly raised tubercle . . . . . 6
5. Mesonotum yellow with two longitudinal stripes; fifth posterior cell about one-fifth as wide as long at its widest point (Brazil).

**P. lutescens** Westwood

Mesonotum entirely dark brown, without stripes; fifth posterior cell about one-half as wide as long at its widest point (Brazil).

**P. antiqua**, new species

6. Wing with vein  $R_{2+3}$  incomplete, not reaching wing margin; thorax and abdomen orange with black maculations (Ecuador).

**P. ecuadorensis**, new species

Wing with vein  $R_{2+3}$  complete, reaching wing margin; thorax all black, abdomen dark brown, yellow only on parts of tergites IV–VI (Brazil).

**P. lomata** Erichson

### *Pialea antiqua*, new species

FIGURES 2,b; 3,g,h; 4,c,e

**FEMALE:** Length of entire specimen 9.70 mm.; wing length 8.75 mm.

**COLOR:** Brown and black; head except antennal tubercle, ocelli, proboscis and distal one-fifth of antennal segment III black; remainder of specimen dark brown except tip of antennal segment III, narrow apical margins of tergites I–IV, large apical margin on V and all of VI, which are light brown; halter yellow, wing membrane light brown infuscated, wing veins and squama brownish yellow, pulvilli white.

**PILE:** Yellowish brown, about same density over entire specimen, little thinner on antennae, that on antennal segments, antennal tubercle, tibiae, and tarsi about as long as antennal segment II, that on all other parts about as long as antennal tubercle; dorsal and ventral surfaces of squama with minute pile, squamal margin with normal length pile, but golden.

**HEAD:** With well developed antennal tubercle (fig. 3,g); eyes in lateral view covering over one-half of head capsule; segment I of each antenna fused only on basal one-third (fig. 3,h), about twice as long as segment II; segment III long, tapering to point terminating in apical seta, pile on upper outer surface only; ocellar tubercle not well raised; proboscis visible, short, slightly exceeding proboscis tubercle in length (fig. 3,g).

**THORAX:** Not as strongly arched as in *lomata*; scutellum wider than long; squama narrow, paper thin, evenly arched in middle, rounded behind; femur of each leg longer than corresponding tibia, tarsi with metatarsi not compressed (fig. 4,e), tibial spur on each leg about as

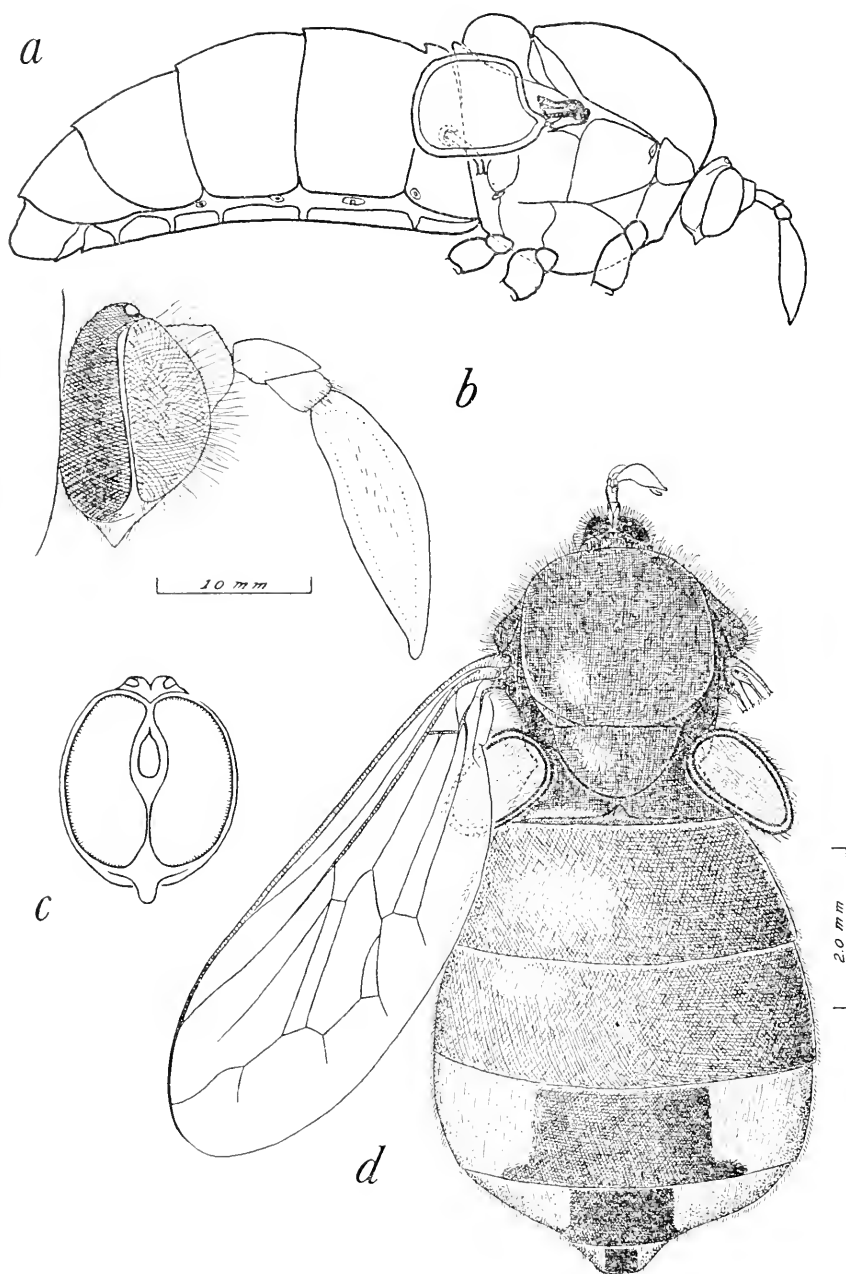


FIGURE 1.—*Pialea capitella*, new species: *a*, lateral view of body; *b*, lateral view of head; *c*, anterior view of head; *d*, dorsal view of body.



long as tarsal segment IV; wing with six posterior cells, anal vein widened apically, m crossvein  $2\frac{1}{2}$  times r-m crossvein.

ABDOMEN: Long, narrow, somewhat sunken from loss of eggs; stigmata of segments II–VI free in intersegmental membrane.

HOLOTYPE: Female: Alto Itatiaia, Rio de Janeiro, Brazil, altitude 2,000 meters, March 1941 (R. C. Shannon), USNM 62979.

REMARKS: There is some question in my mind as to whether this species belongs in *Pialea*. It is closely related to *lutescens*, judging from the latter's description, and shares with it such characters as strong wing venation with a widened anal cell and six posterior cells, the large antennal tubercle, and the same type of antennae, including the weakly fused first segment as figured by Wandolleck (1914, pl. 1, fig. 16) for *lutescens*. It would be interesting to know if *lutescens* has the same tarsal structure as *antiqua*, or whether it is more like *lomata*. As stated previously, these two species may form a distinct genus, but, in the absence of more material and definite males of both species, it seems better to place *lutescens* and *antiqua* in *Pialea* at present.

*Pialea lutescens* Westwood

FIGURE 2,c

*Pialea lutescens* Westwood, 1876, pp. 513–514, pl. 6, fig. 2 and details.—Bezzi, 1912, p. 78.—Brunetti, 1912, p. 474; 1920, pp. 160–163.

I have not examined any specimens of this species, and apparently the only known specimen is the type, which I deduce from Westwood's drawings to be a female.

The characteristic features of *lutescens* as gleaned from the original Latin description and the figures presented by Wandolleck (1914) are as follows: Entire body clay-yellow, somewhat pubescent; dorsum of thorax more yellowish, with two lateral black vittae; antenna deflexed, last segment somewhat compressed, all segments with some pile; wings with six nearly complete posterior cells, only first and fifth complete, anal cell widened apically.

Wandolleck's (1914, pl. 1, figs. 16, 17; pl. 3, fig. 2) figures of *lutescens* seem to be more accurate than Westwood's, as the latter showed slight variation in the wing venation in his two figures of the same specimen. It may be assumed that Wandolleck's drawings were made from the type, as he had access to the Hope Museum Collection, where the type is now located.

This species is related to *antiqua* as discussed under the latter species. Both of these species appear to be as close to *Stenopialea beckeri* Speiser from Capeland, South Africa, as to any known *Pialea* species. The only locality data known for *lutescens* is "Brazil."

*Piulea lomata* Erichson

FIGURES 2,a; 3,b; 4,d,f

*Piulea lomata* Erichson, 1840, p. 161, pl. 1, fig. 9, (9)p—Westwood, 1876, p. 513.—Brunetti, 1912, p. 274.—Bezzi, 1912, p. 78.

REDESCRIPTION (based on type specimen): FEMALE: Length of entire specimen 9.50 mm. wing length 8.80 mm.

COLOR: Black, brown, and yellow; head except eyes and antennae, thorax except upper sternopleura, midpteropleura, and coxae dull black; eyes and ocellar tubercle shiny black; antennae, ocelli, halteres, upper sternopteropleura, midpteropleura, tergites I–III, IV except lateral margins and small median spot on V–VI, sternites I–IV except narrow apical margins and V–VI in broad median area, basal two-thirds of femora and tibiae, tarsal segments I and V, and distal two-thirds of tarsal claws dull or partly shiny brown; tergite IV except broad median area, V–VII except narrow median spot, narrow apical margins of sternites I–IV, lateral and apical margins V–VII, apical one-third of femora and tibiae, knees, tarsal segments II–IV, pulvilli, and basal third tarsal claws dull yellow; wing hyaline, lightly yellow infuscated, veins yellowish brown; squama yellow, shiny, hyaline with brownish yellow margin.

PILE: Yellowish white; on eyes, antenna, occiput, femora, tibiae, squama, and tergites except lateral margins about as long as antennal segments I and II combined, on thorax, coxae, sternites, lateral abdominal margins about as long as hind tarsal claw; dense on thorax, and apical sternal margins of abdomen, otherwise sparse on abdomen except dorsal lateral margins.

HEAD: With ocellar tubercle raised; frontal region raised with small antennal tubercle; proboscis concealed behind cone-shaped tubercle; antennae about as long as head height, segment I of each antenna fused except for slight distal fracture, about as long as hind tarsal segment II, antennal segment II short, about half as long as antennal segment I, segment III about as long as eye height, rounded apically, somewhat compressed laterally; eyes nearly evenly separated above and below antennae, a little less below.

THORAX: With scutellum hardly wider than long, about one-half width of mesonotum; squama nearly tear-drop shape, transparent, rather flat; femur of each leg about as long as corresponding tibia, each tibial spur about as long as corresponding tarsal segment II, tarsi about as in figure 4,g but basitarsus not quite as expanded distally; wing with five posterior cells, anal cell nearly as long as second basal cell, narrow and straight, arculus crossvein present only between M and Cu<sub>1</sub>, m crossvein about 2½ times as long as r-m crossvein.

ABDOMEN: Widest at segment III, shaped about as in figure 1,d, somewhat sunken from loss of eggs, except segments V–VI, rigid due

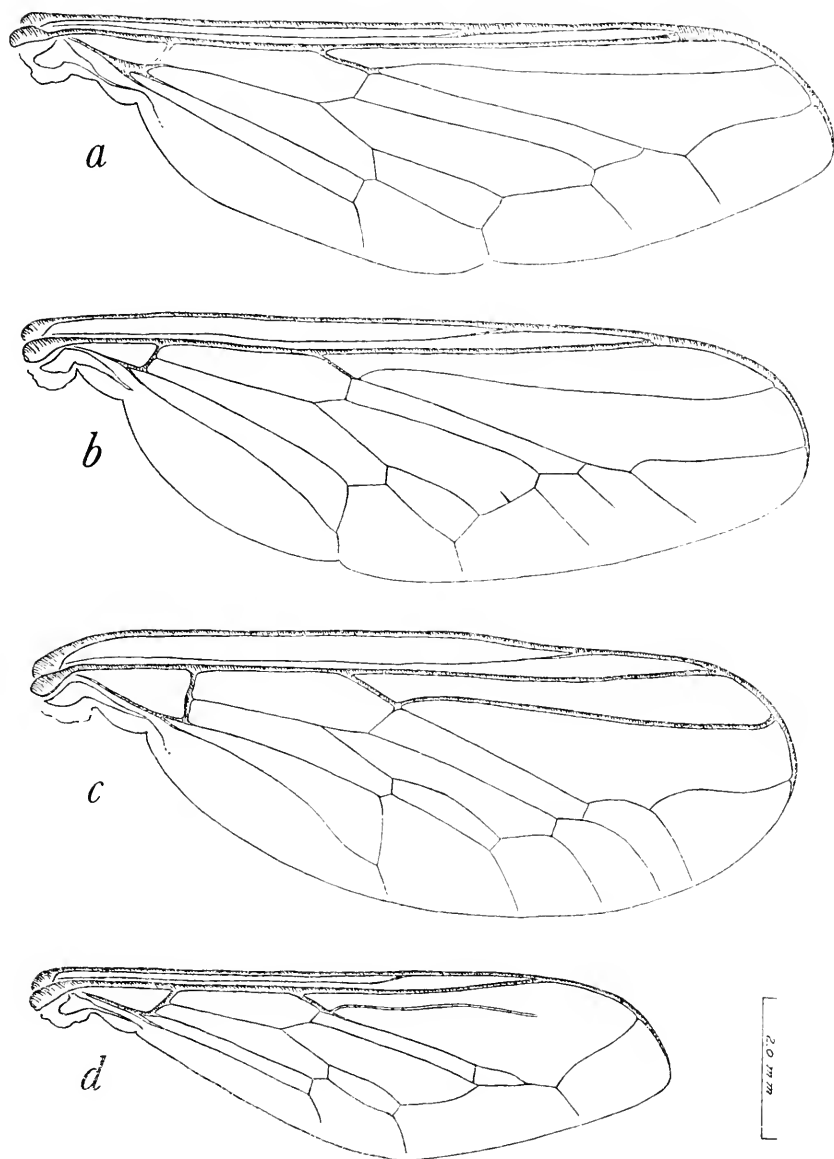


FIGURE 2.—Wings of four species of *Pialca*: *a*, *P. lomata* Erichson; *b*, *P. antiqua*, new species; *c*, *P. lutescens* Westwood (reconstructed from Wandolleck, 1914, pl. 3, fig. 2), *d*, *P. ecuadorensis*, new species, male paratype.

to structure of genitalia; genitalia missing; stigmata free in intersegmental membrane of segments II-IV.

REMARKS: The type female specimen bears the following labels: A white one with "*Pialea* Er.," a blue-green one with "*lomata* Er.," a blue-green one with "San João del Rey, Sellow," an orange one with "Type," and a small white one with the number "1247." The type is in the Deutsches Entomologisches Institut, Berlin, Germany, and is in very good condition except for missing right front leg, tarsi of leg II and III, apical portion of left wing, and genitalia.

The type locality "San João del Rey" has been located on different maps, and was also found to be spelled as "San João d'El-Rey" and "São João del Rei." It is a locality about 250 km. northwest of Rio de Janeiro in the State of Minas Gerais, Brazil. Two of the three other Brazilian *Pialea* species have been collected in the same vicinity, i.e., near Rio de Janeiro and near São Paulo, thus representing an isolated Brazilian distribution at present, as the other species, *lutescens*, is recorded only from "Brazil." The new species *ecuadorensis*, from Ecuador, hints at a much larger distribution.

Erichson (1840) gave an excellent color figure of the whole specimen of *lomata*, but his figure of the head (fig. (9)p) gave an erroneous impression of the antennal insertion by implying a ventral insertion. Bezzi (1912) examined a specimen of *Pialea* from São Paulo and, although he gave no figures, he said the antennae were bare, implanted on a special tubercle which was placed nearer the vertex than the mouth. This indicates he had a male and very probably it was *lomata*.

This species may be more closely related to *ecuadorensis* than to *capitella*, judging from the similarity of the basal cells and general cell structure, particularly in the shape of the first posterior cell. However, it has five posterior cells as in *capitella*.

***Pialea capitella*, new species**

FIGURES 1,a-d; 3,i; 4,a

MALE: Length of entire specimen 11.25 mm.; wing length 8.40 mm.

COLOR: Black, brown, and yellow. Head, except antennal segments II and III, black; antennal segments II, III except upper inner basal third, thorax except sternopleura and meropleura, legs except knees, pulvilli and basal third of tarsal claw, squama, wing veins, sternites I-VII except along narrow apical margins, tergites I-III, and tergites IV-VI in broad median quadrangular area (fig. 1,d) dark brown; upper inner basal third of antennal segment III, pulvilli, basal third of tarsal claws, lateral margins of tergites IV-VI, and wing membrane brownish yellow.

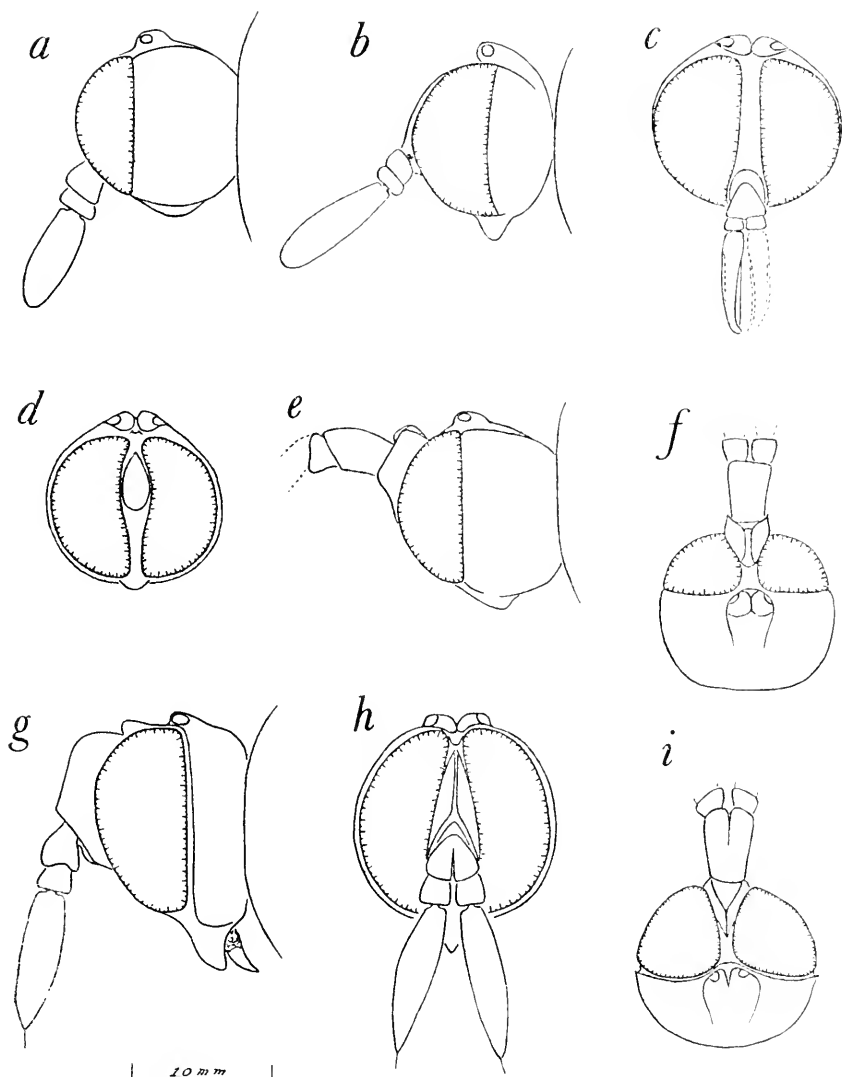


FIGURE 3.—Heads of four species of *Pialea*. *P. ecuadorensis*, new species: *a*, female, lateral view; *c*, same, anterior view; *d*, male, anterior view; *e*, same, lateral view; *f*, same, dorsal view. *P. lomata* Erichson: *b*, lateral view. *P. antiqua*, new species: *g*, lateral view; *h*, anterior view. *P. capitella*, new species: *i*, dorsal view.

**PILE:** Yellowish brown; on eyes, occiput, mesonotum, mesopleura, scutellum, and tergite I about as long as antennal segment I, that on abdomen much shorter, concolorous with ground color, about one-half as long as rest of pile; yellowish white on legs, propleura, upper sternopleura, meropleura, and squama.

**HEAD:** With ocellar tubercle elevated; antennal tubercle large (fig. 1*b*); proboscis concealed behind cone-shaped tubercle; antennae much longer than head height, segment I of each antenna fused on basal half, shining, apilose, produced above over segment II, about as long as eye width, segment II about half as long as I, covered with short, sparse hairs, segment III longer than head height, concave in outer median area, concave region with few scattered hairs.

**THORAX:** Well arched in front; scutellum little wider than long; squama greatly expanded behind near thorax, opaque, curved sharply along distal inner margin; femora progressively longer from first to third, each longer and in same proportion to tibiae I-III; each tibia with two (inner and outer) subequal spurs, each spur nearly as long as corresponding tarsal segment II; metatarsus about as in figure 4*g*, but a little longer, length of segments II-IV equals distitarsus, basitarsus not as expanded distally; wing with five posterior cells, fourth not bounded basally by second basal cell, vein  $R_{2+3}$  incomplete, not reaching wing margin, vein  $R_4$  swinging upward near apex causing narrowed submarginal region, anal cell narrow, about as long as second basal cell, basal cells nearly equal length, m crossvein about three times r-m crossvein.

**ABDOMEN:** Rather compressed dorsoventrally, flattened beneath, slightly convex above, tergite I cleft medially, well raised along posterior margin; stigmata free in intersegmental membrane of segments II-IV; genitalia not examined, broken off inside specimen.

**HOLOTYPE:** Male; Cantarera, near São Paulo, Brazil (Wettstein Brazil Expedition, 1891). The type will be deposited in the Vienna Naturhistorische Museum, Austria.

**REMARKS:** The characteristic incomplete vein  $R_{2+3}$  of *capitella* shows a relationship to *ecuadorensis*, but whether this is a factor of relative or convergent evolution is not determined. Such other characteristics as two tibial spurs and the larger eyes causing a different shaped head capsule are distinctions which suggest a more distant relationship. This species is probably closer to *lomata*, as discussed under the latter. Also, the character of the two equal-length basal cells in *capitella* is unique for the genus, and it therefore seems that this species has no known close relative.

The name *capitella* refers to the minute head, which is also a character of *Pialea*.

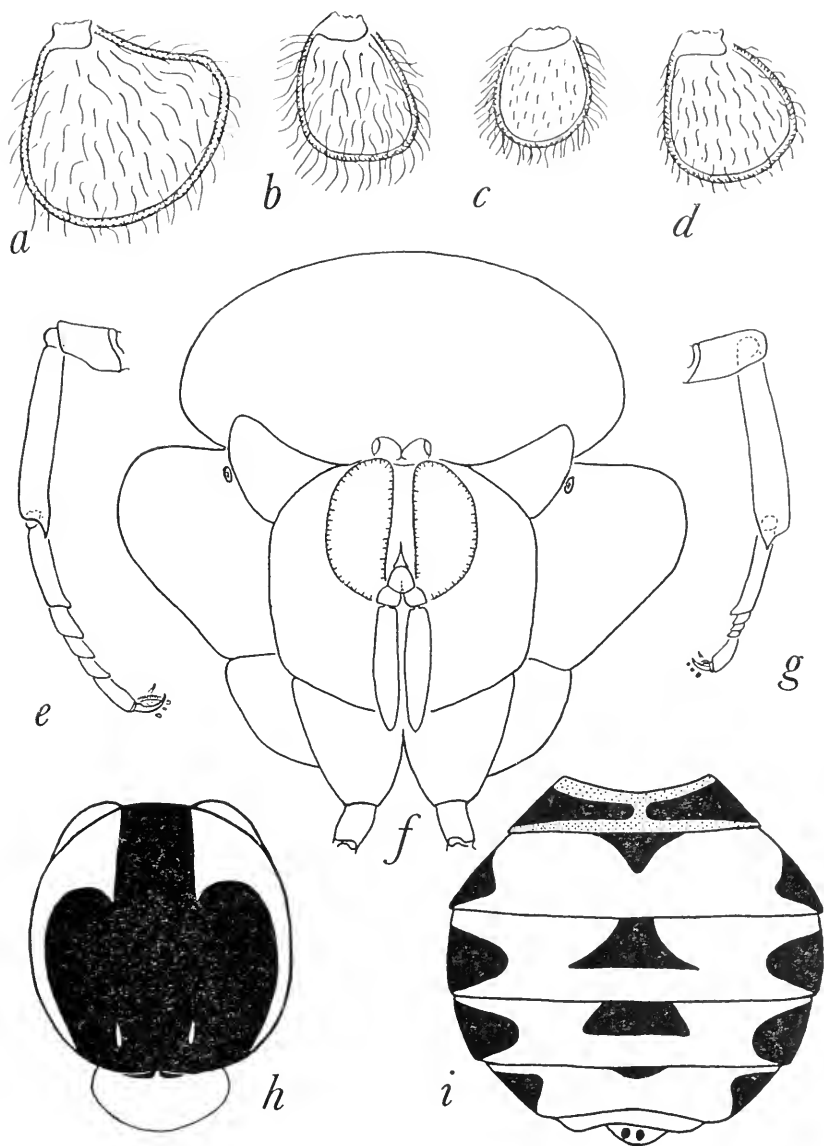


FIGURE 4.—a-d, Left squama, viewed from above in flat plane, of: a, *Pialea capitella*, new species; b, *P. ecuadorensis*, new species, female; c, *P. antiqua*, new species; d, *P. lomata* Erichson. e, *P. antiqua*, new species, hind tibia and tarsus viewed from outer side; f, *P. lomata* Erichson, head and thorax, anterior view; g-i, *P. ecuadorensis*, new species, female: g, hind tibia and tarsus viewed from outer side; h, mesonotum and scutellum, dorsal view; i, abdomen, dorsal view.

*Pialea ecuadorensis*, new speciesFIGURES 2,*d*; 3,*a,c,f*; 4,*b,g-i*

FEMALE: Length of entire specimen 7.25 mm.: wing length 7.25 mm.

COLOR: Orange, black, and brown; head except antennal segments II-III, pleurae except small spot on upper mesopleura, mesonotum except anterior angle and lateral margin (fig. 4,*h*), and halter except extreme base dull black; antennal segments II-III, coxae, basal two-thirds femur II, tibia II, femur, tibia, and basitarsus leg III, sternites I-V, tergite I, lateral margins and median triangular areas of tergites II-V (fig. 4,*i*), cerci, and stronger wing veins dark brown; anterior angle and lateral margin of mesonotum, proepisternum, small spot on upper mesopleura, spot at upper junction of sternopleura and meropleura, postalar callosity, scutellum, and remainder of abdomen orange; wing membrane faintly browned, squama light brown with yellowish brown margin, pulvilli light brown.

PILE: Golden yellow. Dense on eyes, occiput, thorax, squama, abdomen, and legs except tarsi; that on head about as long as antennal segments I-II combined, that on thorax about as long as antennal segment III, that on abdomen sparse, longer than on thorax, intermixed with dark brown hairs, particularly along posterior margins of tergites I-IV, that on sternites without brown hairs, that on tarsi quite short, appressed; hind tibia with dark brown and black pile, that on antennal segments II-III short, lightly brownish yellow, pilose.

HEAD: With ocellar tubercle a point; frontal region only slightly raised, antennal tubercle minute; proboscis hardly visible underneath small proboscis tubercle; antenna little shorter than head height, segment I of each antenna completely fused, about as long as hind tarsal segments III-IV, segment II about half as long as I, round, segment III about three-fourths eye height, rounded apically, compressed laterally; eyes occupy anterior third of head capsule, separated a little more below than above antennae.

THORAX: Maculated (fig. 4,*h*); scutellum much wider than long; squama nearly straight behind, narrow, nearly opaque, almost flat; femur and tibia of each leg nearly equal in length, tibial spur about as long as corresponding tarsal segment II, metatarsus compressed (fig. 4,*g*); wing as in figure 2,*d* except no crossvein present in first posterior cell, and third posterior cell (subdiscal) divided near apex (right wing only); four posterior cells, anal vein narrow, vein  $R_{2+3}$  incomplete, not reaching wing margin, faint, inserted slightly posterior to r-m crossvein, m crossvein about five times r-m crossvein.

ABDOMEN: Short, a little longer than thorax, widest at segment III, maculated (fig. 4,*i*), somewhat sunken from loss of eggs, except segments V-VI, rigid due to structure of genitalia.



MALE: Length of entire specimen 8.75 mm.; wing length 6.60 mm. As described for female except as follows:

COLOR: Black and brown; head except antennal segment II, pleurites except spots between sternopleura, meropleura, and mesopleura, mesonotum except faintly lightened anterior lateral angle, halter, scutellum, and tergites II-V dull black; antennal segment II, spots around sternopleura, anterior lateral angle of mesonotum, tergites I and VI, sternites I-VII, legs, and strong wing veins dark brown; no orange coloration.

PILE: Same as in female except that on head about as long as male antennal segment II, that on thorax about as long as male antennal segments I-II combined; pile on abdomen distinctly different, being bicolored, yellowish white and brown; on tergite I-II brown except yellowish white near midline, tergite III all brown, tergite IV brown except yellowish white at lateral margins; tergite V has a little brown along base, otherwise yellowish white; tergite VI all yellowish white; all abdominal pile about as long as thoracic pile except that on middle and margins of tergite II, long, nearly as long as front basitarsus.

HEAD: With large antennal tubercle placed above mideye height; antennal segment I twice as long, but completely fused, as in female, segment II twice as long in ventral as in dorsal view, much as in *capitella* (fig. 1, *b*), segment III missing.

THORAX: Not maculated, mesonotum slightly lighter colored along anterior and lateral angle; wing as in figure 3, *a* except in left wing no crossvein in first posterior cell.

ABDOMEN: Longer than thorax, rigid, stigmata as in figure 1, *a*; genitalia missing.

HOLOTYPE: Female; Calacali, Ecuador, altitude 2,800 meters, 1937 (F. Campos R.), USNM 62980.

PARATYPE: Male: Same data as holotype, also in USNM.

REMARKS: The type specimens of this species were collected in the same place in Ecuador by the same man, and presumably on the same date. It has therefore been assumed that the two specimens represent the two sexes of the same species, and it is largely on this evidence that the generic concept taken by the author has been set forth. Since this is the only species of *Pialea* with both sexes adequately described (see discussion under *lomata*), the sexual difference in color complicates the matter even further. However, on the basis of wing venation and other shared characters, there seems little doubt that the association made in *ecuadorensis* is correct and not a combination of the sexes representing two species or even two genera.

This species extends the distribution of *Pialea* several thousand miles from Brazil and yet, of all the species known to me, it is prob-

ably closer to *lomata* than any other. It is, however, easily distinguished from *lomata* in its wing venation. Due to the rather poor chances of these acrocerids crossing the high Andean range in Perú, Ecuador, and Colombia, it may be that further species will be obtained in Venezuela and Colombia, and that the extent of the presumably tropical genus has or had a circum-Andean distribution in the north. As to the validity of the locality data for *ecua.lorensis* I have no doubt, as Señor Campos has collected for many years in Ecuador. Cole's endemic Ecuadorian genus, *Camposella*, was named for this collector.

It should be pointed out that the wing venation as shown in figure 3, *a* is atypical in one sense—the crossvein in the first posterior cell is adventitious and does not occur in the left wing of the male or in either wing of the female holotype. The right wing of the male was drawn only because it was in better condition for study.

I have made the female the holotype of this species since it is as surely a *Pialea* as *lomata*. It is of course possible, though not at all probable, that the males described in this work represent another genus. The female specimen was in better condition, the male lacking the terminal segment of the antennae and four of the legs. Both specimens were slightly oily, but not badly rubbed. The female specimen lacked the left terminal antennal segment also.

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FURTHER DATA ON AFRICAN PARASITIC CUCKOOS

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BY HERBERT FRIEDMANN

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The data assembled in this paper extend our knowledge of African parasitic cuckoos from the basic facts presented in my book entitled "The Parasitic Cuckoos of Africa" published in 1949 and the little addendum to it (Friedmann, 1949b) published later in the same year. In the present account only those data pertinent to the problems of parasitic reproduction are included. For this reason, some species of cuckoos are not discussed at all as there were no new facts to describe. Even in those that are treated in this paper almost no space is given to such items as call-notes, migration, food of the adult, plumages, etc.

For sending me unpublished information, for answering many queries, and for other acts of kind cooperation, I am indebted to the following naturalists: C. F. Belcher, J. P. Chapin, F. Haverschmidt, R. Liversidge, P. Millstein, E. Pike, O. P. M. Prozsky, R. A. Reed, and W. Stanford. The photographs illustrating this paper were supplied by Mr. Liversidge in addition to his information. His observations on the red-chested cuckoo (Liversidge, 1955), unpublished when sent to me, fortunately appeared in print just as the present manuscript was about to leave my hands. I have therefore merely summarized his data insofar as integrating all the information has permitted.

*Clamator glandarius* (Linnaeus)

## Great-spotted cuckoo

Three new hosts may be added to those listed in my book, one of which is only a race of a species of which another form was already recorded as a victim of the great-spotted cuckoo. The first of these is the dwarf raven (*Corvus corax edithae*), a bird of which Belcher (1949a, p. 37) records a nest found near Gabredarre, Ogaden, Italian Somaliland, containing three or four eggs of the great-spotted cuckoo and three or four eggs as well as one young of the host. Previously only the Spanish race of this raven (*C. c. hispanus*) had been reported as a host of the nominate race of the cuckoo.

The second is the piapiac (*Ptilostomus afer*). I have no data on this other than that it is mentioned as a victim of the great-spotted cuckoo by Mackworth-Praed and Grant (1952, p. 505).

The third new host is the long-tailed glossy starling (*Lamprolornis caudatus*). Madden (1934, p. 94) saw a fledgling great-spotted cuckoo apparently being fed by a pair of these starlings at El Obeid, Kordofan, Sudan, in November 1932. Aside from adding an additional species to the known hosts of this parasite, this record seems to be the first for any hole-nesting bird north of South Africa. As pointed out in my book (Friedmann, 1949a, p. 10), the data then available showed a puzzling divergence in the choice of victims by this cuckoo in South Africa on the one hand, and everywhere else in its range on the other. In the former area most of the records were of hole-nesting birds (three species of starlings), while all the records from Nyasaland and Southern Rhodesia north to the Mediterranean lands were of birds making open nests in trees or on ledges (crows and magpies of several species). It is true that one open-nest builder, the Cape rook, was known to be parasitized in South Africa; now we may further reduce the apparent geographical disparity in host selection with this indication of the choice of a hole-nesting victim as far north as the Sudan.

In my earlier report (Friedmann, 1949a) I considered all the populations of the great-spotted cuckoo as one taxonomic unit. Since then, Clancey (1951, p. 141) has separated the birds south of the Sahara under the name *choragium*, restricting the name *glandarius* to the birds that breed in Spain, Portugal, Mediterranean Africa, Cyprus, Greece, Asia Minor, and Iran and that migrate south in winter to tropical Africa. It follows from this that there again seems to be a regional difference in host selection. The nominate race is known to utilize only open nests, chiefly of corvids of several kinds, whereas the African *choragium* lays in such nests and in those of hole-nesting starlings as well.



*Clamator jacobinus* (Boddaert)

## Jacobin cuckoo

New information gathered on the jacobin cuckoo does more than merely yield additional instances of its parasitism on previously recorded hosts. Many additional records of its eggs in nests of Layard's bulbuls (*Pycnonotus tricolor layardi*), sombre bulbuls (*Andropadus importunus importunus*), and fiscal shrikes (*Lanius collaris collaris*) corroborate the predominance these hosts play in the economy of the parasite, but, merely as records, they add no revealing new data. Two additional instances of the bakbakiri (*Telephonus zeylonus*) added to the three listed in my book suggest that this shrike is more frequently victimized than was formerly suspected. These instances are: (1) a nest found at Butterworth, Cape Province, by Pike on February 4 with one egg of the host and one of the parasite, and (2) a case reported by A. W. Vincent (1949, p. 138) from Richmond, Natal.

Two new host species may be recorded. Skead (1954, p. 46) reports that an egg of this cuckoo was found in a nest of the paradise flycatcher (*Terpsiphone viridis perspicillata*) at Fleet Ditch Kloof, near King William's Town, eastern Cape Province, on Dec. 18, 1954. In the Victoria Memorial Museum at Salisbury in 1951 I found a set of two eggs of the grassbird (*Sphenoeacus afer transvaalensis*) with one egg of the jacobin cuckoo, taken at Inyanga, Southern Rhodesia (no date), by Flight Lt. E. F. Allen. This is not only a record of a new host but also is the only instance known to me of the parasite using a nest built close to the ground. The one record of the jacobin parasitizing a kingfisher, described in my book (Friedmann, 1949a, p. 31), may well be questioned; it may have been a honey-guide's egg.

In my earlier account (Friedmann, 1949a, p. 36) of the hosts of this parasite I raised some doubts as to two cases recorded by de Klerk of the jacobin cuckoo laying its eggs in nests of the yellow-throated sparrow (*Petronia superciliaris*) and suggested that the records might refer to honey-guides. However, de Klerk's measurements are too large for any honey-guide's eggs and agree very closely with other, authentic eggs of the jacobin cuckoo. The records must therefore be accepted, but it remains that the host is a very unusual one, nesting, as it does, in holes in trees, a type of nesting site not otherwise known to be utilized by the jacobin cuckoo.

## INCUBATION PERIOD

The incubation period is still to be determined, but Skead's (1951, pp. 171-172) incomplete evidence suggests a shorter period than did my own similarly fractional data (Friedmann, 1949a, p. 37). It may

be recalled that the nest I was watching was destroyed 14 days after the last host's egg was laid and the smashed cuckoo's egg in the nest seemed then about in hatching condition. One of Skead's cases suggested a possible incubation period of  $12\frac{1}{2}$  days, while his second one seemed three days less, and caused him to ask if the cuckoo's egg might begin its development some time prior to ovulation. It would seem unlikely that the incubation period is under  $12\frac{1}{2}$  days.

#### EVICTING HABIT

Our knowledge of the evicting habit in the jacobin cuckoo still requires clarification. In 1949 (Friedmann, 1949a, p. 37) I was aware of no real evidence and could only conclude that while the young cuckoo was almost always the sole survivor of a nest, the absence of any of the rightful young might be the result of their failure to compete for food with their parasitic nest-mate rather than that they were actually evicted alive by it. Skead (1951, pp. 172-173) has described an instance in which the nestling jacobin tolerated eggs and young in the nest for up to four days, and another in which it made no attempt to evict eggs for four days but in which a chick of the host was found to disappear within less than a day after hatching (but not necessarily evicted by the cuckoo). In the first case, Skead comments that, considering how the young cuckoo covered and almost suffocated its nest-mate (a Layard's bulbul), the "possibility of death of nestlings by this means must not be ruled out. The chick was so weak . . . when retrieved . . . that had it remained there much longer, it would have been smothered. Therefore, I wish to draw attention to the suffocation of cuckoo's nest-mates and the possibility of their subsequent removal by the foster-parents during nest-sanitation . . . ."

In this connection, an observation by Pike recorded by Godfrey (1939, p. 23) and inadvertently overlooked in my earlier report is of interest. At Butterworth, Transkei, Cape Province, he found a nest of a fiscal shrike on January 15 containing only one egg—a jacobin cuckoo's. On February 27 the nest was revisited and was found to hold a young jacobin and three young shrikes. Still later he saw the four young birds perched on twigs near the nest, and still later he noted that the young shrikes had left but the cuckoo was still being fed by an adult shrike. This is the only definite instance known to me of the nest-mates surviving together with a jacobin cuckoo. From this, and from the two instances described by Skead, in which eviction by the cuckoo, if any took place, did not occur for some days after hatching, it follows that evicting is certainly not invariable or immediate, and, for that matter, it is still not possible to say that the young parasite was responsible for any evictions.

Actually, this is not surprising when we consider that in the related great-spotted cuckoo, the rightful young often, and perhaps even regularly, grow up together with the parasite. Furthermore, two young jacobin cuckoos have been noted as growing up together with one of the young of a babbler host (*Argya malcomli*) in India, a further indication of the lack of evicting behavior (Bates, 1938, p. 125).

#### EGG LAYING

Pike (again cited in Godfrey, 1939) found, on December 4, another nest of the fiscal shrike containing one egg of the jacobin cuckoo; two days later it contained two shrike's eggs in addition to the cuckoo's, and three days later still it held five eggs of the shrike and the one egg of the jacobin. Pike was unable to visit the nest again. It would appear from this case and the one referred to previously that the cuckoo may lay occasionally into nests before the builder has begun to lay. It is, of course, not impossible that in each instance there may have been a single shrike's egg present and that the cuckoo removed it when laying its own. It is, however, not very likely that this was the case, as the usual number of eggs in a clutch of the shrike is four or five, and in these cases there was no reduction as would have been the case had the cuckoo removed an egg. In my earlier account of this parasite (Friedmann, 1949a, p. 30) I summarized the then available information on this point, and I have seen no evidence to cause me to change it since: "No one has witnessed the actual deposition of the egg, but judging by the fact that the number of eggs of the host is usually less than the full complement by the number of cuckoos' eggs in the nest, it seems that the cuckoo usually removes an egg before laying into the nest . . . ." Of course, if—as seems to have been the case in the two instances described above—the cuckoo's egg is laid first there can be no such removal of a host's egg.

An observation suggesting that the jacobin cuckoo may at times be an egg-eating nest robber is the following sent me by Pike, who once saw some red bishop birds (*Euplectes orix*) chasing one of these cuckoos away from their nests. Two of the nests each had a hole of about an inch and a half in diameter torn in the lower part; one of the nests contained two eggs of the builder, one being badly pecked and empty and the other also broken; the bottom of the nest was moist with spilled yolk.

In my earlier account of this cuckoo (Friedmann, 1949a, p. 30) it was mentioned that only a single instance was known in Africa of more than two eggs of this bird in one nest, although in India Stuart Baker had recorded six nests with three eggs of the parasite apiece, two nests with four, and one nest with six eggs attributable to the jacobin cuckoo. The lone African instance was a nest of the sombre

bulbul (*Andropadus importunus*) with five eggs of the cuckoo and two of the host, reported by Ivy (1901, pp. 23-24). It was to be expected that the situation in the African population of this cuckoo would prove to be similar to that in the Asiatic part, and this has recently been found to be the case. Mr. H. M. Miles of Salisbury, Southern Rhodesia, informs me (in litt.) that nearby, at Plumtree School, on Mar. 2, 1954, Mr. Ian Cannell found a nest of Layard's bulbul containing seven eggs of the cuckoo and one broken egg of the bulbul. He also found another nest of the same host with four eggs of the cuckoo and one egg of the bulbul.

*Clamator levaillantii* (Swainson)

Stripe-breasted cuckoo

Recently in South Africa, Milstein (1954, pp. 4-5) produced evidence indicating that this cuckoo may lay pure white eggs as well as the greenish blue and pinkish ones described in my book. The case is as follows. He saw two stripe-breasted cuckoos perching in a wild fig tree in which there was a nest of a yellow-vented bulbul. The cuckoos repeatedly hopped towards the nest and the bulbuls kept them at bay, diving onto their backs, gripping, and literally riding them to the ground. The intruders, fluttering wildly, never retaliated even when one of the bulbuls yanked out a tuft of whitish breast feathers from one of the cuckoos. Milstein watched this repeated attack and counterattack for over an hour and a half. He then left, but returned several hours later when he examined the bulbul's nest for the first time. It contained two eggs of the bulbul and four large white eggs, presumably of a cuckoo. The two bulbul eggs and three of the parasitic eggs were snugly settled in the nest, but the fourth white egg, slightly pinkish (freshest?) was on the rim of the nest, almost falling out. Milstein was inclined to assume that the fresh egg had been laid during his absence by one of the stripe-breasted cuckoos that had shown so much interest in the nest a few hours earlier. The four white eggs measured, in millimeters, as follows:  $27 \times 22.25$ ,  $26.6 \times 21$ ,  $26.25 \times 21.5$ , and  $25.25 \times 20.75$ . In this respect they agree with known eggs of both the stripe-breasted cuckoo and the pied cuckoo; in color they agree with authentic eggs of the latter. It is to be hoped that further observations, including allowing such eggs to hatch and develop into diagnostically feathered chicks, may be forthcoming.

To the still meager data on the breeding season of this cuckoo in various parts of its range may be added the fact that Verheyen (1953, pp. 305-306) records that it breeds during the rainy season in the Upemba Park, Belgian Congo, where males with swollen gonads were collected on October 7 and March 15.

*Cuculus canorus gularis* Stephens

## African yellow-billed cuckoo

Information about this bird accumulates very slowly; however, it is possible to add a new species to the small list of its known hosts. Mr. H. M. Miles, of Salisbury, writes me that a correspondent of his, J. R. Peters, found a nest of Layard's bulbul (*Pycnonotus tricolor layardi*) containing a young yellow-billed cuckoo on Oct. 9, 1955, at a spot called Guinea Fowl, 12 miles southeast of Gwelo, Southern Rhodesia. At that time the nest contained two newly hatched bulbuls as well as the young cuckoo. Ten days later the nest was revisited and was found to hold only the young parasite. It was at this visit that the young cuckoo, then well feathered, was identified as *Cuculus canorus gularis*.

Neuby-Varty (1950, p. 38) found the gray-headed sparrow (*Passer griseus diffusus*) to be victimized in Southern Rhodesia. At his farm "Torre," near Marandellas (no date given), he found a nest of this sparrow in a natural hole in a sugarbush containing two eggs of the sparrow and one of the African yellow-billed cuckoo. The egg of the latter was very light bluish gray with blotches of slate and dark greenish olive brown, mostly at the thick end but also scattered over the rest of the egg, and measured  $23.5 \times 16$  mm. This agrees very well with the fully authenticated oviduct egg described by the same observer (Neuby-Varty, 1948, p. 158) two years earlier. This record is the first indication that this cuckoo lays in nests in holes in trees, the few previous records involving open nests in exposed situations.

In the Victoria Memorial Museum, Salisbury, is an egg, supposedly of this cuckoo, collected by D. Towmley at Rumanai, Southern Rhodesia, Dec. 20, 1929, from a nest of an unidentified babbler. The label on the egg bears the words "identity sure," and the egg is not unlike authentic ones of this cuckoo. No babbler has yet been recorded as a victim of this bird, but this case must remain unidentified.

*Cuculus solitarius* Stephens

## Red-chested cuckoo

## PLATES 1-3

Our knowledge of several phases of the life history of this cuckoo has increased greatly in the past few years. For easier reference and discussion these data may be treated under various subheadings.

## EGGS AND EGG LAYING

When compiling the data for my book I was unable to find an instance of more than one egg of this cuckoo in any single nest. Tait (1952, p. 135) has since recorded such a case—a nest of *Cossypha*

*caffa drakensbergi* with one egg of the host and two of the cuckoo. The cuckoo eggs were sufficiently dissimilar in color to suggest that they were laid by different hens. There is, as yet, no evidence to indicate that the same cuckoo may lay more than one egg in a nest.

While it is true, as stated in my book (Friedmann, 1949a, pp. 68-69), that the great majority of the known eggs of the red-chested cuckoo are plain pale chocolate brown or olive brown without any markings, a sufficient number of divergent types since have been recorded from southern Africa to make it seem that there is more variation than was formerly apparent. Thus, in the Bryanston district, near Johannesburg, Transvaal, Reed (in litt.) found a red-chested cuckoo's egg in a nest of a Cape robin-chat together with one egg of the owner, which it closely resembled, being olive green in color and heavily blotched with reddish brown, the blotches forming an almost solid mass at the obtuse end of the egg. In another nest of the same host species he found another egg of this cuckoo (identity certain because the egg was allowed to hatch and the development of the chick followed in detail). This egg has a fawn colored ground and was heavily blotched with dark reddish brown. Still another parasitized nest of the Cape robin-chat was found containing an egg that presumably was of this cuckoo. It was "off white" in color and very heavily speckled with large, dark brown spots.<sup>1</sup> That three such divergent, blotched or spotted eggs were found in one locality seems to eliminate, or to render doubtful, the possibility of their being unusual or pathological in any sense. Still another color variant has recently been described in Northern Rhodesia by Haydock (1950, pp. 149-150) as deep cream in color and with a very rough shell texture.

So few observations are available on the question of whether or not the hen cuckoo removes an egg of the host when depositing one of its own that the following case, incomplete as it is, is of some interest. Liversidge (in litt.) writes me of a parasitized nest of a Cape robin-chat, a bird whose name occurs under several headings in our present discussion. The nest was found by the observer's landlady, who was certain that one day the nest was empty and the next day it contained an egg of the cuckoo and one of the host. This would suggest that the cuckoo laid the same day as the robin-chat and did not remove an egg at that time. It is, of course, not impossible that the cuckoo may have laid its egg earlier in the day than did the host, and that there was no egg for it to remove. As I have recorded previously (Friedmann, 1949a, pp. 69-70), the red-chested cuckoo seems to lay not infrequently in nests before the host has

<sup>1</sup> This egg is not dissimilar to known eggs of *Cuculus cafer*; the possibility cannot be ruled out that the egg may have been of the black cuckoo.

begun laying. In at least one instance where the cuckoo laid in a nest already containing eggs of the host, it did remove one of them when depositing its own.

#### INCUBATION PERIOD

The nest of a Cape robin-chat studied by Liversidge, mentioned above, yields the following information on this topic. The person who first showed him the nest was quite definite that the eggs (one each of the cuckoo and the host) were first present on September 21 (about a week before Liversidge first saw the nest). The cuckoo's egg hatched on October 7, which implies that at least 16 days elapsed between the time the egg was laid and the date of hatching. It is not known, however, if the host began to incubate on or immediately after September 21; but at least it is clear that no eggs were laid in the nest subsequent to the two seen on September 21, and it would seem that incubation may well have started on or just after the date of laying. This account leaves much to be desired, but it suggests an incubation period somewhat longer than the one of 12½ days reported for the related European cuckoo, *Cuculus canorus*. More accurate data are needed to clarify this point.

#### HOST RECORDS

Accumulation of many additional host records indicates even more strongly than before that the robin-chat *Cossypha caffra* is the chief victim of the red-chested cuckoo wherever the two occur together. At least three subspecies of the *Cossypha* are now known to be parasitized: the nominate one, for which I had numerous records previously and for which I could add at least as many new ones now; the tropical race *iolaema*, earlier listed on the basis of a single instance to which several more may now be added (Wiley, 1948, p. 2); and the subspecies *drakensbergi*, recently found to be victimized at Underberg, Natal, by Tait (1952, p. 135).

The Natal robin-chat was previously listed as a host of the red-chested cuckoo solely on the strength of Roberts (1939, p. 8), who lists it in this capacity. No specific records or other data were given by him. Recently Mr. H. M. Miles has informed me that at Melsetter, Southern Rhodesia, a correspondent of his saw a fledgling of this cuckoo attended by a Natal robin-chat. There is nothing unexpected about this record, but it is a welcome additional indication to the not too informative statement given by Roberts.

One species has been added to the list of known hosts by Haydock (1950, pp. 149–150) at Luanshya, Northern Rhodesia. This is another species of robin-chat, *Cossypha heuglini*, in a nest of which he found, on October 22, two eggs of the owner. An hour later a red-

chedsted cuckoo was heard calling near the nest. It was perched on a small branch nearby. One of the chats was standing on the edge of the nest in a threatening attitude. The next morning the nest contained one of the original eggs and another much larger one that measured  $25.7 \times 18.2$  mm. It was ovate, deep cream in color, and had a very rough shell texture. A week later the nest was found to be empty when revisited. Beuson (1951, p. 98) found another parasitized nest of this robin-chat at Ketete, Nyasaland, on September 22. It contained one egg of the host and one of the cuckoo. Near Marandellas, Southern Rhodesia, Neuby-Varty has reported seeing a young fledgling red-chested cuckoo with a Heuglin's robin-chat, according to information received from Mr. Miles.

Haydock (1950, pp. 149-150) records the following observation suggestive of the possible utilization of a hole-nesting host, a starling, by the red-chested cuckoo. He writes that on Dec. 17, 1948, a pair of *Lamprocolius* sp. were seen feeding a young cuckoo recently out of the nest. On close inspection (the bird was caught) the latter appeared to be a red-chested cuckoo chick, having "the typical yellow legs and feet, and differing from *C. gularis* in being practically a uniform black, though there were some traces of rufous on the thighs and marginal tail feathers, and odd feathers of the breast were tipped with a dirty white . . . ." The identification of the starling fosterer was impossible as the birds were not collected, but Haydock was inclined to feel that the species probably was *Lamprocolius chloropterus elisabeth*, a form previously known to be nesting in the area.

Aside from the uncertainty as to the species of starling involved, the evidence is not sufficiently conclusive to enable us to add it (even as *Lamprocolius* sp.) to the list of birds definitely recorded as hosts of this parasite. Merely seeing a bird feeding a fledged cuckoo is not necessarily proof that it raised the latter. In this connection, it may be pointed out that Harding (1948, p. 2) saw a young red-chested cuckoo, out of the nest, being fed by a Fischer's slaty flycatcher (*Dioptrornis fischeri*). The next day he observed the same cuckoo being fed by a pair of collared sunbirds (*Anthreptes collaris*).

In their recent book, Mackworth-Praed and Grant (1955, pp. 318-319) write that the white-winged scrub-robin (*Erythropygia leucophrys leucophrys*) is a common victim of the red-chested cuckoo. Just what data or how many actual instances of parasitism were known to these authors is, unfortunately, not stated. In my earlier account I listed but a single record under the name *Erythropygia leucophrys brunneiceps*. This refers to the same bird, although it may be pointed out that Mackworth-Praed and Grant use the name *brunneiceps* now for a race of *Erythropygia zambesiana*, a species not yet found to be imposed upon by the red-chested cuckoo.



The Cape wagtail (*Motacilla capensis*) was previously listed as a host of the red-chested cuckoo on the basis of two records. To these may be added two more, a nest found in the Transkei, Cape Province, containing one egg of the cuckoo (E. Pike, in litt.), and a nest of the race *Motacilla capensis wellsi* with three eggs of the wagtail and one of the cuckoo found at Kabete, Kenya Colony, Apr. 26, 1944, by Wiley (1948, p. 2).

A second record of the dusky flycatcher (*Alseonax adustus*) as a victim of this cuckoo comes to me from Walter Stanford (in litt.). On Dec. 22, 1952, at Deep Gat, Somerset West, Cape Province, he found a nest of this flycatcher containing one egg of its own and one egg of the red-chested cuckoo. The nest was built in a little recessed hollow in a tree trunk. On revisiting the nest two weeks later, Stanford found that the cuckoo's eggs had not hatched, while the flycatcher's egg had done so and the young *Alseonax* was well feathered.

A host overlooked when compiling my earlier account is the Cape sparrow (*Passer melanurus melanurus*). C. J. Bergh (1942, p. 99) writes from Belfast, Transvaal, that he has known the red-chested cuckoo to lay its eggs in a "mossie's nest." The name "mossie" is loosely used for several species of sparrows but is usually intended to refer to the Cape sparrow.

#### EVICTING INSTINCT

Considering the complete absence of any information on this topic up to the time of the completion of my 1949 book, and, indeed, the amount of evidence suggestive of the lack of such behavior, it is gratifying that a number of detailed pertinent observations have since been made. There can no longer be any doubt that the evicting of nest-mates is commonly, perhaps regularly, done by newly hatched red-chested cuckoos, but it still seems necessary to qualify this with the statement that it seems to be less universal in this species than in the European cuckoo. In the latter bird it is extremely rare to find the young cuckoo tolerating any nest-mates.

Aside from Pringle's account, which I have briefly described (Friedmann, 1949b, p. 515), I now have data on three more instances, all in nests of the Cape robin-chat (*Cossypha caffra*). Reed (1952, pp. 14-15) has described one such instance, and has kindly supplied me with fuller details, which are given here as they constitute a better record of events than his condensed printed one.

On Dec. 25, 1951, near Johannesburg, Reed discovered a nest of the robin-chat with three eggs, one of which was a red-chested cuckoo's. The nest was kept under close observation, and on the morning of January 1 he found that the cuckoo's egg had hatched but that the robin's eggs were still intact in the nest. By 7 a. m. of January 3

both robin eggs had been ejected from the nest. One lay on the ground at the base of the tree and the other lay in a fork of the tree beside the nest. Fortunately, neither egg was visibly damaged. Reed replaced one egg in the nest with the cuckoo chick and watched the bird try immediately to eject it. However, when the chick had gone through the performance of carrying the egg on its back to the edge of the nest and the egg had rolled back into the nest, Reed removed it. He repeated the experiment on January 4 with the same result, but when he tried again on January 5 he was unable to induce the chick to attempt to eject the egg. To make quite certain that the bird had lost all desire to eject it, he placed the egg on its back, but the chick lay passively and made no attempt even to remove it. Reed then broke both robin-chat eggs and found no sign of incubation in them.

Another nest was found by the same observer on November 29. It contained a newly hatched cuckoo and a robin-chat's egg. On December 2 the host's egg was found lying on the ground just below the nest. Reed replaced this egg in the nest two days later, but not even putting it directly on the back of the chick would induce the latter to attempt to evict it. The young cuckoo was at least 6 days old at that time; therefore, this case agrees with the more fully described one in that the instinct to eject the nest-mates was found to disappear before that age.

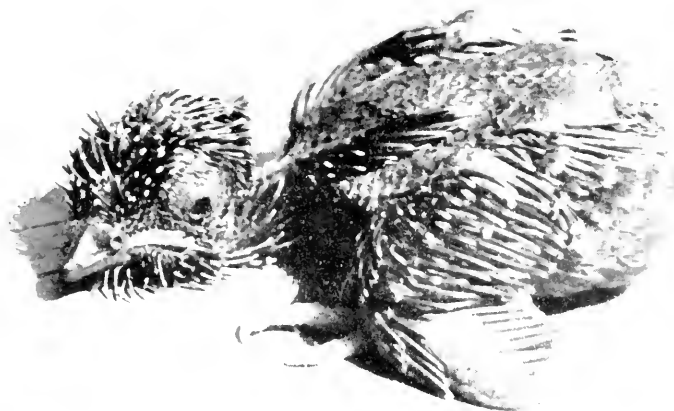
Near Cape Town, Liversidge (in litt.) watched a nest of a Cape robin-chat containing one egg of the cuckoo and one of the host and made detailed notes. (Also, he kindly supplied the photographs for use in this paper.) The cuckoo egg hatched, and within 24 hours the host's egg was out of the nest. Liversidge put it back, but a few hours later, when Dr. Broekhuysen visited the nest, it was out again. The lady in whose garden the nest was located was asked to keep up observations, to replace the egg in the nest each time, and to see how often the young cuckoo would evict the egg. After three more evictions in 10 minutes, the observer lost some of her attentiveness but reported that the chick threw out the egg many more times that day, the total of such evictions being in excess of 25 by the time the observations were called off. The chick was later given eggs of various sizes and shapes, and even small stones, all of which it evicted, or, at least, attempted to eject. This went on until its fourth day. On the fifth day an egg, when placed in the nest, was allowed to remain there, but the ejection movements of the young cuckoo could still be induced by prodding its back. Liversidge writes that the chick did not have any hollow space on its back, which was quite broad and flat. When ejecting an object, however, the back becomes slightly concave, as in the case of the well known European species, *Cuculus canorus*.



Cape robin-chat bringing food to a young red-chested cuckoo in its nest.  
(Photo by Liversidge.)



One-day-old red-chested cuckoo ejecting host's egg from nest. Sequence: left to right top to bottom. (Photos by Liversidge.)



Growth of young red-chested cuckoo. *Top*: 3 days old; first feathers breaking out of their sheaths. *Bottom*: 19 days old; one day before leaving the nest. (Photos by Liversidge.)



## THE NESTLING AND ITS DEVELOPMENT

When I wrote my earlier account of this cuckoo there were almost no data on the growth and development of the young bird in the nest. Within the next year Hughes (1949, pp. 2-4) filled in part of this gap in our knowledge, while Liversidge (1955) has since filled a good deal more. In addition to these data, there are available some observations kindly supplied me by R. A. Reed. It is from these three combined sources that the following description is compiled.

To begin with the more important items: The duration of the nestling stage (i. e., from the time of hatching to leaving the nest) of this cuckoo in nests of the Cape robin-chat was found by Reed to be from 17½ to 19 days, by Liversidge to be 20 days  $\pm$  6 hours, while in the nest watched by Hughes the young cuckoo was found to have been killed by a predator in the nest on its 20th day; one leg, severed from the body, was all that remained. The nestling period for the related European cuckoo, *Cuculus canorus*, is 20 days, agreeing with the data for the present species.

On hatching, the young cuckoo is devoid of down and is very dark all over. According to Hughes it is shining black; Reed describes it as dark bluish black; and Liversidge records it as brown, changing within the next two days to purplish brown. The gape at first is yellowish orange with yellowish edges, but becomes wholly bright orange by the end of the second day. The bill is dark horn color with a whitish egg-tooth; the feet are dark flesh color. Liversidge found a day-old chick to weigh 4.9 grams.

On the fourth day the quill-like, stiff feather sheaths appear on the upper surface of the wings. The next day these sheaths are 3 mm. long and show some black pigment basally; on this day sheaths first appear on the cervical tract. On the sixth day the skin over the eyes begins to open, but only slightly, hardly enough to enable the bird to see. On this day the sheaths begin to show up on the chin, forehead, and sides of the breast, flanks, and abdomen, the longest ones are twice as long as they were on the fifth day, 6 to 7 mm. By the seventh day the cuckoo, now more than four times its natal weight, shows the first sprouting of feathers out of the sheaths on the wings and tail according to Hughes; Liversidge reports this as taking place on the eighth day, and notes that the feathers are grayish with a white terminal bar. On this day sprouting also begins on the sides of the breast, and by the end of the ninth day this condition extends along the entire ventral tract.

On the 10th day the eyes fully open, a most important change in the development and behavior of the chick. The rest of the plumage breaks from the enclosing sheaths on this day and the next and the bird suddenly becomes quite fluffy, a marked change in appearance.

On the 11th day the bird begins to ruffle its plumage, a type of movement not indulged in hitherto. The feathers, now all out of the sheaths, become darker, more pronouncedly blackish and less grayish due to the increased area of their newly freed portions. The ventral edge of the bend of the wing is white, the alula is black, and the under primary coverts are black with white bars; the feathers of the breast and sides of the abdomen are light buff with a black subterminal and a broad buff terminal bar; the feathers of the midabdomen and thighs are paler. On the 12th day the rectrices show the contrasting white tips very markedly because of the growth of the dark proximal portion of the feathers. By this day, or, in one case, even two days earlier, the young cuckoo has grown so that it completely fills the nest.

On the 15th day the remiges and rectrices are noticeably longer than the rest of the plumage. From this stage on until the chick leaves the nest, the changes are only matters of rapid growth. The feet are now yellow, whereas originally they were flesh colored.

By the time it leaves the nest the cuckoo has grown in weight more than 11 times its hatching size. Liversidge's bird weighed 4.9 grams at birth and nearly 60 grams when it left the nest.

Aside from the purely physical development of the bird, as outlined above, Liversidge has put on record some highly interesting observations of the growth and change of its behavior. For the first five days, as noted in our discussion of the evicting instinct, the chick reacts to nest-mates (eggs or other chicks) by getting them on its back and pushing them out of the nest. This reaction is very weak on the first day, very strong on the second, and normally ceases on the fourth day, but it can still be evoked by artificial stimulation on the fifth day. During this period the gaping response of the chick is usually straight up in direction.

A second stage begins with the parting of the skin over the eyes. Gaping is now directed toward the entrance of the nest, i. e., toward the direction of the light, rather than merely upwards, and may be induced by either touching and slightly jarring the nest or by a sharp whistled sound near the nest. Liversidge, however, considers that this directional gaping is more the result of an originally conditioned stimulus than of a visually oriented one. The location of the nest necessitated the same approach by the foster parents when visiting it, and gaping became directed toward the entrance. It is true, however, that the gaping did become more directional at the time the eyes began to open, even though the first day or so they were not open enough to give the chick really effective or efficient vision. Both Liversidge and Reed observed the first threatening reactions on the eighth or ninth days. Reed noted that the chick erected the feathers of the head and neck and opened the bill, revealing the



bright orange gape. On a closer approach, the bird reacted by darting its bill forward to strike the hand that was extended toward it, an action much more aggressive than any feeding behavior. Liversidge found that on the eighth day the eyes were open slightly early in the morning but were closed again in the evening. It was not until the 10th day that the bird seemed able to make full and continuous use of its eyes; on this day the chick first reacted to movements of his hand. This, it may be noted, is a little later than in Reed's experience, and may reflect the range of individual variation in the rate of this stage of the development.

The first noise uttered by the chick, according to Liversidge, was heard on the 10th day, a quiet, chattering note. The next day this note, now much louder, was used apparently only in connection with begging for food. The original gaping reaction given in response to touching the nest continued up to the 11th day, but by the evening of the 12th day such stimulation only elicited threatening reactions.

The period from the 15th day of nestling life onward to the time the chick is fledged and leaves the nest is characterized by a greater variety of activities. The bird first begins to preen on the 15th day, at first in a haphazard, apparently nonfunctional way, but rapidly becoming fully functional. On this day the nestling was first seen trying to stand up, unsuccessfully at first, but soon becoming better at it. On the 18th day Liversidge's bird first practiced stretching its wings, and from then on it quivered its wings whenever begging for food or being fed. On this day, also, it first seemed to distinguish the call of the foster parents, but showed no ability to differentiate between the various notes given by the robin-chats while at the nest. Reed observed that when the young cuckoo had left the nest it apparently was able to distinguish the alarm note and to react accordingly.

We still know very little about the postnestling stage of the young cuckoo's development, the stage when it becomes separated from the care of its host and becomes self-sufficient. Reed banded a young red-chested cuckoo before it left the nest of its foster parents and found it being fed by them as much as 13 days after it left the nest. It continued to remain within a radius of 50 yards of the nest for at least a month, after which it was seen no more.

Stanford (in litt.) watched a pair of Cape robin-chats feeding a young red-chested cuckoo some days out of the nest. He first found the latter by hearing its low-pitched but incessant "tsip-tsip-tsip" notes. When the robin-chats came close to it, the bird's calling increased in intensity; the young cuckoo bent forward, opened its bill, partly opened and drooped its wings and ruffled its plumage. The call became much louder and was repeated more frequently, the bill opening and closing spasmodically all the while. Once the bird

had been fed it calmed down promptly. He saw it fed eight times in 30 minutes, mostly on what seemed to be grubs, spiders, and grasshoppers.

#### BREEDING RANGE

The first indication that the red-chested cuckoo may breed in West Africa is a record of a female with a well yolked egg in the ovary collected on August 6 at Lake Bambalue, near Bamenda, British Cameroons (Bannerman, 1951, p. 274).

#### *Cuculus cafer* Lichtenstein

#### Black cuckoo

Since the publication of my earlier account of this rather shy and secretive cuckoo, additional data, especially on the development of the nestling and, to a lesser extent, on the evicting habit, have been recorded. This is principally due to Skead's (1951, pp. 163-168) observations. In his area in the eastern Cape Province he found the boubou shrike (*Laniarius ferrugineus*) to be the regular, and, as far as his own experience went, the only host of the black cuckoo.

The new data, filling what was formerly a complete blank in the record concerning the growth and development of the young bird, may be summarized briefly as follows. On the first day after hatching the bird is naked, dark purplish in color, the gape pink, the back noticeably flat (not concave), and the eyes closed. On the fourth day the sheaths of the rectrices, remiges, and flank feathers begin to emerge; on the fifth day those of the feathers on the nape, throat, and forehead begin to appear; by the sixth day the bird has sheaths all over except on the back which is still nude. The eyes begin to open on the seventh day, and the bird begins to squeak softly. The feather sheaths begin to emerge on either side of the bare spinal area on the eighth day. By the ninth day the eyes are fully open; the back is still largely bare. The feathers start bursting from their sheaths on the 11th day, but the primary remiges are still encased in their sheaths. On the 16th day the bird is well feathered all over, and shows fear reactions by gaping with the head up and back, not forward as when expecting food; on the 21st day the bird was gone from the nest and was never seen again. The nestling period is therefore not more than 21 days. In the European cuckoo it is said to vary from 20 to 23 days.

In another nest of the boubou shrike Skead found a newly hatched black cuckoo and two eggs of the host. The next day one of the shrike's eggs hatched. The following day the young cuckoo was the sole occupant of the nest and no sign could be found of the shrike's egg or chick. The probability is that they were ejected by the cuckoo, but the ejection was not witnessed. The nest, being a rather shallow cup,

was such as would present no obstacle to ejection by the cuckoo. The inference is that the young parasite (definitely identified as a black cuckoo by its plumage when the feathers had grown out) tolerated, or at least did not eject, its nest-mates for the first 48 hours. It is, of course, unsafe to draw any hard and fast comparisons between a single instance in this species with what is known in its relatives, the red-chested cuckoo and the European cuckoo, but it may be pointed out that the eviction of its nest-mates was delayed in the case of the black cuckoo for at least 48 hours, as compared with less than 24 hours in a similar situation involving the red-chested cuckoo, and about the same in cases of the European cuckoo.

*Cuculus poliocephalus* Latham

Lesser cuckoo

Although this cuckoo does not remain in Africa during its breeding season as far as known, some courtship feeding behavior of interest has recently been recorded in Northern Rhodesia. Grimwood (in Smithers, 1952, p. 107) watched five of these cuckoos at Danger Hill, 25 miles from Mpika. Of these birds, two "pairs were indulging in what appeared to be courtship flights, chasing one another from perch to perch, and on alighting going through a feeding behaviour, though no food was seen to be transferred." While not surprising, it is of interest to find still another parasitic cuckoo exhibiting this atavistically revealing behavior pattern.

*Chalcites cupreus* (Shaw)

Emerald cuckoo

Additional data on this bird have to do with its host species and with its courtship behavior.

HOST RECORDS

In 1949 I quoted a peculiar account (Friedmann, 1949b, pp. 516-517) of the emerald cuckoo based on observations made on Principe Island that were attributed to Keulemans and published by Buller (1873, p. 76). Mr. F. Haverschmidt has since sent me a translation from the Dutch of Keulemans' (1866, pp. 363-401) observations on the birds of Principe Island. There is no mention of the queer story related by Buller, but merely Keulemans' statement to the effect that he was told by the inhabitants that this cuckoo deposits its eggs in the nests of *Cuphopterus Dohrni* (= *Horizorhinus dohrni*) and *Parinia leucophaea* (= *Speirops lucophaea*), which breed in the summer, and that it probably deposits them in the nests of other species as well.

A much later, and little known, paper by Keulemans (1907, pp. 245-247) gives further welcome details. He writes that the female emerald cuckoo lays her eggs in the nests of smaller birds that build open, cuplike nests, and mentions *Zosterops ficedulinus* and *Speirops leucophaea* as the usual foster parents. Of the latter species of host he relates a remarkable observation he made in July 1863 on his plantation on Principe Island. "Behind my small dwelling house grew a large Acacia tree, the branches of which nearly touched the balcony. A pair of *Parinias* (= *Speirops*) had built their nest so near the verandah that I could hear the young ones while they were being fed. One morning the pleasant sound of this young family calling for food had suddenly ceased. A week later I noticed a young Cuckoo lifting its head above the nest. Stranger still, two or three days later a second young cuckoo was to be seen in the same nest, and both these intruders were fed, not only by their original foster parents but also by at least a dozen other small birds." The nest and its contents came to grief a few days later.

These three hosts in Principe Island—*Horizorhinus dohrni*, *Zosterops ficedulinus*, and *Speirops leucophaea*—are all additional to our previous list. It is unfortunate that no details of actual instances are available for either of the first two. While there is nothing improbable in their being parasitized by the emerald cuckoo, Keulemans' unsupported statement does not constitute evidence in itself, and it cannot be claimed that birds of the first two species are known definitely as fosterers of the emerald cuckoo.

It may be pointed out that the *Speirops* case described above gives us the first evidence that more than one emerald cuckoo egg may be laid in one nest. We have no way of knowing if the two eggs were the product of a single bird or of two different individuals.

Winterbottom (1951, p. 27) lists the puff-backed shrike (*Dryoscopus cubla*) as a host of the emerald cuckoo but he gives no further data. Mackworth-Praed and Grant (1952, p. 509) also list puff-backed shrikes, together with bulbuls, as the usual hosts of this cuckoo. However, I am aware of but a single specific instance of the puff-back in this capacity (J. Vincent, 1934, p. 761; a record overlooked before). The puff-back shrike is known better as a victim of the black cuckoo. However, its ecological habitat is much less strictly sylvan than that of the emerald cuckoo, being more like that of the black cuckoo.

On the other hand, hosts additional to those previously listed are indicated in the following observations. Guichard (1950, p. 168) found the Abyssinian bulbul (*Pycnonotus barbatus schcanus*) to be victimized at Addis Ababa, Ethiopia, while in Nyasaland Benson (1953, p. 35) records eggs of the emerald cuckoo in nests of *Chalomitra senegalensis gutturalis* and *Cyanomitra olivacea alfredi*. Benson also

lists (p. 113) a nest of the paradise flycatcher (*Terpsiphone viridis*) with two eggs of its own and one egg of the emerald cuckoo found at Blantyre, Nyasaland, on November 26. This flycatcher was previously known as a host from a single instance in the Belgian Congo. The subspecies in Nyasaland is *T. v. granti*, while the Congo bird is *T. v. viridis*. The crimson-crested black forest weaver (*Malimbus malimbicus crassirostris*) is added to the list of the known victims on the following basis. The van Somerens (1949, p. 95) record an egg (identified as an emerald cuckoo's by Pitman) from a nest of this forest weaver in the Bwamba area, Toro, western Uganda. An egg of the weaver, punctured and empty, lay on the ground below the nest.

One other bird not definitely known to be parasitized by the emerald cuckoo has been reported in a way suggestive of such a relationship. Holliday and Tait (1953, p. 116) watched a nesting pair of olive barbets (*Buccanodon olivaceum woodwardi*) at Ngoye Forest, Zululand. Once, when the barbets had gone foraging for food for their nestlings, an emerald cuckoo "approached the nest, made certain that the adult barbets were nowhere in the vicinity, and disappeared from view into the nest hole. All the time this was going on the young birds kept up their continuous clamour. Whilst the intruder was still within the nest, one of the parents arrived on the scene, and finding the unwanted visitor, attacked it fiercely and drove it away from the nest site. Owing to the fact that the nest was inaccessible, an examination of the nestlings was not possible, but one might assume that one of the chicks was probably a young cuckoo, and the parent was taking an active interest in its welfare, for it is not likely that it would be looking for a suitable nest in which to lay its eggs at this stage. As little is known about the breeding habits of Emerald Cuckoos, it is felt that this record is of some value, for some observers have seen it frequenting the nests of other species of barbets during the breeding season." The assumption that the adult cuckoo came to the nest because of a presumed interest in the welfare of an equally hypothetical nestling of its own kind has little enough to support it, but the fact that the cuckoo showed some interest in the nest suggests that such a site might be within the range of its potential choice of a receptacle for its eggs. Hitherto no hole-nesting bird has been found to be parasitized by the emerald cuckoo, or, for that matter, by any of the African metallic cuckoos of the genus *Chalcites*.

#### COURTSHIP BEHAVIOR

When I wrote my earlier account of this cuckoo nothing was known of its courtship behavior. Since then this gap has been partly filled by the interesting and valuable observations recorded by Haydock (1950, p. 150). He saw a female emerald cuckoo perched on a bare

branch of a defoliated tree. A male was on a higher branch, calling loudly; it flew down to the hen and, with wings drooping and tail erect, bobbed in front of her, and presented her with a large hairy caterpillar. This offering was accepted and devoured, the cock bird calling loudly with its head thrown well back during this time. A second similar display was then gone through, after which coition was attempted unsuccessfully. Shortly after this both birds flew away. Haydock's observations were made in central Northern Rhodesia in the third week in January.

In my earlier account of this cuckoo, mention was made of the fact that male birds seemed to be "territorial" and to establish singing posts to which they adhered day after day. These observations I made in western Kenya Colony. Welcome corroboration by virtue of similar observations now is available from the Upemba Park, Belgian Congo, where Verheyen (1953, pp. 319-320) found the same situation. He goes further and writes that the males reserve a well defined area which they defend against the intrusion of other males. This is, however, an unsupported statement as he does not describe any actual instances of territorial defense, and all I knew previously was merely the fact that males sang persistently from their singing posts.

In Principe and San Thomé Islands, Keulemans (1907) found this cuckoo to be migratory, being present on the islands only from February until November.

#### *Chalcites klaas* (Stephens)

#### Klaas's cuckoo

#### HOST SPECIES

All the new information on this cuckoo refers merely to additional host records, the total of which may now be raised from the 33 species listed in my earlier accounts to 42 species, or, if we count species and subspecies, to 50 forms. Of the total of all instances of this bird's parasitism known to me, 30 percent are with sunbirds as hosts, 23 percent with flycatchers, 16 percent with weavers, and the rest single or, at most, two records for wagtails, bulbuls, babblers, starlings, white-eyes, and finches. While 30 percent of the parasitized nests are those of sunbirds, the 10 species of this family recorded as hosts of the cuckoo amount to not quite 25 percent of the total known species of victims. Similarly, seven species of flycatchers, or about 16 percent of the total of 42 kinds of hosts, account for almost 25 percent of the recorded instances.

The arrow-marked babbler (*Turdoides jardineii*) is listed as a host of Klaas's cuckoo by Winterbottom (1951, p. 15), but no specific instances are given. I am not aware of any published pertinent data.

Another new host is the dusky flycatcher (*Alseonax adustus*), a pair of which were seen feeding a young Klaas's cuckoo on December 6 in Hottentot's Holland, Cape Province, by MacLeod and Murray (1952, p. 22). Still another species of *Alseonax*, the Uganda pygmy dusky flycatcher (*A. minimus pumilus*), may be added to the list, this one on the basis of three records. Williams (1946, p. 138) found a nest of this bird at Kampala, Uganda, on Apr. 27, 1946, that contained two fresh eggs of the builder and one very slightly incubated egg of the cuckoo. At Kitale, Kenya Colony, Stoneham (1952, p. 7) found two nestling Klaas's cuckoos, one in each of two nests of this flycatcher, near the garden of the museum early in 1952.

According to Benson (1953, p. 35), the gray tit-babbler (*Parisoma plumbeum orientale*) has been found to be parasitized in Nyasaland; he gives no further data on it, and lists it as an "apparent" host of Klaas's cuckoo.

In my book (Friedmann, 1949a, p. 140) I listed the Cape flycatcher (*Batis capensis*) as a host of this cuckoo solely on Joubert's statement that it was victimized in the Cape Province. Since then MacLeod and Murray (1952, p. 17) have recorded two instances in the Hottentot's Holland area, and Stanford (in litt.) sends me the following additional cases. On December 6 at Pienie Bush, Somerset West, Cape Province, he and J. G. MacLeod found a young Klaas's cuckoo, not quite ready to fly, completely filling a nest of a Cape flycatcher. Within 30 yards of this nest was another nest of the same species that had had a young Klaas's cuckoo in it a day or two earlier. In this area, in the years 1951-1952, Stanford and MacLeod found a total of five instances of the Cape flycatcher serving as host for Klaas's cuckoo.

To the previous meager data on the Cape paradise flycatcher (*Terpsiphone perspicillata*) may be added another instance, recorded at Hottentot's Holland by MacLeod and Murray (1952). The related *Terpsiphone viridis* is a bird of which two races, the nominate one and *suahelica*, have been previously listed as victims of Klaas's cuckoo. It seems that the race *speciosa* may serve in this capacity as well. Chapin (1953, p. 725) mentions a nest at Avakubi that contained one egg of the builder and one egg that probably was of this cuckoo.

The rufescent swamp warbler (*Calamocichla rufescens*) is a bird not hitherto recorded as a victim of Klaas's cuckoo. Chapin writes me that near Tshibati, Belgian Congo, on Feb. 27, 1954, he found a nest of this bird high up on a fork of a stalk of elephant grass that contained a well-feathered nestling Klaas's cuckoo. The foster parents were "scolding" nearby as he examined the nest. The race of the host in the eastern Congo is probably *foxi*.

At the time of my first report (Friedmann, 1949a, p. 141) I knew of only two instances of the bar-throated warbler (*Apalis thoracicus thoracicus*) being parasitized. This number may now be increased as a result of observations by Skead (1952, p. 12), who found one such case in December 1946 and two more in January 1947.

The long-billed crombec (*Sylvietta rufescens transvaalensis*) was previously known as a victim of this cuckoo on the basis of a single case. To this may be added another quite unusual one. Mr. O. P. M. Prozesky informed me when I was in the Transvaal that on Dec. 27, 1950, at Buffelspoort, 50 miles northwest of Pretoria, he found a pair of crombees feeding two fledgling Klaas's cuckoos.

Another host previously known from one record and for which a second has now come to my attention is the gray-backed bush warbler (*Camaroptera brevicaudata abessinica*). Sir Charles F. Belcher writes me that he found a parasitized nest of this bird in Kenya Colony. The warbler had deserted it.

The tawny-flanked longtail, *Prinia mistacea* (subsp. *melanorhyncha*), was known to be victimized in the Gold Coast. Its eastern race, *immutabilis*, has since been found to be similarly affected in Kenya Colony, where Stoneham (1952, p. 7) found a nest at Kitale with three eggs of the longtail and one egg of Klaas's cuckoo.

Skead's (1954, p. 87) recent study of the greater double-collared sunbird has added six more instances of its usage as a victim by Klaas's cuckoo. It must be regarded as one of the chief hosts of the parasite in the Cape Province.

The East African mouse-colored sunbird (*Chalcomitra verorii fischeri*) has been found to act as a host for Klaas's cuckoo in Kenya Colony by Belcher (in litt.). I had previously listed it as such in northern Zululand, but it now seems that the latter record refers to the nominate race of the sunbird.

*Cinnyris venustus falkensteini* may be added to the known hosts of Klaas's cuckoo, as Mackworth-Praed and Grant (1955, p. 779) record it as being occasionally parasitized in East Africa. Previously I had known of only a single instance, involving the Abyssinian race *Cinnyris venustus fazoglensis* (Friedmann, 1949a, p. 143).

The Kenya rufous sparrow (*Passer iagoensis rufocinctus*) is an addition to the recorded victims of Klaas's cuckoo. Belcher (1949b, p. 19) mentions, without further details, that he has in his collection eggs of Klaas's cuckoo taken from a nest of this sparrow. I understand from correspondence that there were two eggs attributed to the cuckoo in this nest and that the identification of the parasite is not really definite.

Chapin (1954, p. 339) records the masked weaver (*Ploceus intermedius intermedius*) as a host of Klaas's cuckoo on the strength of two



parasitized nests found in Uganda by Pitman. Each contained one egg of the weaver and one egg of the cuckoo.

The southern race of this weaver, *Ploceus intermedius cabanisi*, has also been found to be parasitized by Klaas's cuckoo in Southern Rhodesia, according to Mr. H. M. Miles. It had been recorded previously only as a host of the didrie.

Layard's spot-backed weaver (*Ploceus nigriceps*) was described as a victim of Klaas's cuckoo on the basis of two such instances at Taveta, Kenya Colony (Friedmann, 1949a, p. 146). Farther south, at Mikindani in extreme southern Tanganyika Territory, it also appears to be a frequent victim. Grote (1924, p. 34) considers it a bird often imposed upon there by both this cuckoo and the related didrie.

Masterson (1953, p. 51) recently added the red-headed weaver (*Anaplectes rubriceps*) to the known victims of this cuckoo. On Nov. 6, 1952, at Murambinda, Buhera District, Southern Rhodesia, he found a nest of this weaver that contained three eggs of its own and one egg that was presumed to be of a Klaas's cuckoo. The latter egg was freckled and was paler and slightly narrower than the host's eggs. A Klaas's cuckoo was calling excitedly in the vicinity and three times it tried to enter the nest in spite of the nearness of Masterson's natives who had climbed to the nest. Later, in January 1953, Masterson saw a pair of these weavers feeding a young Klaas's cuckoo in his garden.

The red bishop bird (*Euplectes orix*), a frequent host of the didrie, also has been listed as an apparent host of Klaas's cuckoo in Nyasaland (Benson 1953, p. 35), but without further supporting details.

#### EGGS AND EGG LAYING

Recently MacLeod and Hallack (1956, pp. 2-5) described four eggs of this cuckoo—all laid in nests of the Cape flycatcher (*Batis capensis*)—as pinkish white and heavily spotted with reddish blotches forming a fairly definite ring around the blunt ends. No pinkish white eggs of this cuckoo were previously recorded. These authors think (but do not know) that all four eggs were laid by the same hen cuckoo. This is based on the similarity of the eggs, on the fact that all were found in nests within a limited area, and that all were found in nests of the same species of host. The evidence, if such it may be called, is merely suggestive, but, aside from adding another color type to the known eggs of Klaas's cuckoo, it is the first indication of the number of eggs laid and of host specificity in this species.

#### EVICTON OF NEST-MATES

In my earlier account I stated that while the young Klaas's cuckoo is usually the sole survivor in a nest, no information was available as to whether it evicts the other young or eggs in the nest or starves them

out in competition for the food brought to the nest by the hosts. While the present paper was awaiting publication, MacLeod and Hallack (1956) supplied our first definite observations on this point. They watched a parasitized nest of a Cape flycatcher. The Klaas's cuckoo hatched on November 9, and one of the host's eggs hatched on November 13. On November 14 the young cuckoo evicted the young flycatcher. At 9 a. m. on that day the cuckoo was noted underneath the young flycatcher, trying to heave it out of the nest; this attempt was unsuccessful, and was repeated at 9:25, again unsuccessfully. At 11:42 another attempt succeeded. The young *Batis* was left dangling by one foot, head down, from the outside of the nest. The adult *Batis* returned with food, took no notice of its rightful young, and fed the young parasite. A quarter of a hour later the young flycatcher fell to the rocks below.

*Chalcites flavicularis* (Shelley)

Yellow-throated cuckoo

This rare cuckoo remains still virtually unobserved. Its range may now be extended a short distance eastward to the Bwamba area, Toro, western Uganda, where the van Somerens (1949, p. 29) collected a breeding female at Ntandi in July and where Ridley, Percy, and Percy (1953, p. 163) obtained another female in full breeding condition on September 27 near Hakitengya. The stomach contents of both birds consisted of hairy caterpillars, plus scale insects in the July bird and beetles in the September one.

*Chalcites caprius* (Boddaert)

Didric cuckoo

The new information on this cuckoo may be treated under several subdivisions.

HOST RECORDS

A considerable number of species of birds not listed in my earlier report have now been found to be parasitized by the didric cuckoo, bringing the total of its known hosts to 46 species, or 55 species and subspecies of birds. In addition, our knowledge of some that were included in the 1949 list has been considerably augmented. It becomes increasingly clear that the Ploceidae are the chief victims of the didric cuckoo; approximately three-fourths of all the nests recorded with eggs or young of the cuckoo belong to birds of this family.

The Cape wagtail (*Motacilla capensis capensis*) was included in my (1949a) book on the basis of one, not wholly satisfactory, record. However, an overlooked statement by Nicholson (1897, pp. 142-143)

reveals that in his garden at Pretoria a didrie cuckoo layed an egg in a nest of the Cape wagtail and the egg was hatched and the young parasite reared by the host. Recently, Pike (in litt.) saw one of these wagtails feeding a fledgling didrie on January 8 in the Transkei District, Cape Province. Skead (1952, p. 4) lists three more instances in the Cape Province. The Cape wagtail must be considered as a regular host of this cuckoo.

Winterbottom (1951, p. 15) writes that the didrie is parasitic on the arrow-marked babbler (*Turdoides jardineii*). I know of no definite instance, although it may be recalled that Swynnerton (1911, p. 19) once shot a didrie as it was leaving a nest of this babbler. There was no cuckoo's egg in the nest, however.

The small-billed brown flycatcher (*Bradornis microrhynchus*) is a new host of the didrie. Belcher (in litt.) informs me that he collected an egg of this cuckoo from a nest of this bird near Ngong, Kenya Colony. He felt satisfied as to the identity of the species of cuckoo involved.

The Shoa olive sunbird (*Cyanomitra olivacea ragazzii*) is a possible addition to our previous list of hosts. Reichenow (1881, p. 16) mentions a didrie's egg found by G. A. Fischer in a nest of this sunbird. This egg is said to have been given to the Nehr Korn Collection, but the catalog of that collection makes no mention of it. It is not stated how the identification of the egg was decided; it may have been a Klaas's cuckoo.

Skead (1952, p. 5) has tentatively listed the yellow-throated sparrow (*Petronia supercilialis*) as a victim of the didrie cuckoo, but he states that the parasitic egg seen in the one nest involved may have been that of a greater honey-guide. I think the latter is probably correct; the record should be deleted from the list of didrie hosts.

Vieillot's black weaver (*Ploceus nigerrimus*) was known previously to be parasitized in Uganda and in the Belgian Congo. To this may be added that Serle (1954, p. 55) found a fledgling didrie cuckoo, unable as yet to fly, beneath a nesting colony of these black weavers on January 24 at Kumba, British Cameroons.

The black-headed weaver (*Ploceus melanocephalus*) is a species new to our list of victims, but it was actually recorded in this capacity as long ago as 1899 by Louis Petit (1899, pp. 66-67) in the French Congo. The race of the weaver in that area is *P. m. capitalis* (Latham). Petit writes that the didrie is parasitic on this weaver, and that the latter rears the young parasites.

Two other races of the black-headed weaver may also be mentioned in the present connection. Indefinite observations by Verheyen (1953, p. 315) suggest that Dubois' black-headed weaver (*Ploceus*

*melanocephalus duboisi*) may be parasitized by the didric in the Belgian Congo.

The Uganda yellow-collared weaver (*Ploceus melanocephalus dimidiatus*) has been recorded, without supporting data, as a victim of the didric cuckoo. Distant (1897, p. 143) states that Jackson found an egg "considered to be of this cuckoo" in a nest of this weaver.

To the meager data previously available on Layard's spot-backed weaver (*Ploceus nigriceps*) as a didric victim in southern Tanganyika Territory may be added that Benson (1953, p. 35) found it to be parasitized in Nyasaland as well.

In my earlier account (1949a, p. 173) it was noted that Cabanis' masked weaver (*Ploceus intermedius cabanisi*) had been reported as a fosterer of the didric in South Africa by Roberts. Recently Lamm (1955, p. 34) wrote that this weaver appears to be the principal host of this cuckoo in southern Mozambique. He also suggested that the spotted-backed weaver (*Ploceus spilonotis spilonotus*) is probably a frequent victim of the didric in that region. Previous data on this bird as a host were all from the Union of South Africa.

I have recorded (Friedmann, 1949a, p. 175) the spectacled weaver (*Ploceus ocularius ocularius*) as not too certainly established as a known host of the didric cuckoo. A definite instance has since been recorded by Skead (1952, p. 9) at King William's Town, Cape Province.

Previously (Friedmann, 1949a, p. 176), I included Smith's golden weaver (*Ploceus subaureus subaureus*) as a victim of the didric only on the strength of its being so listed by Patterson and by Sparrow, since no specific instances were known to me at the time. Since then, D. C. H. Flowes has informed me that at Umkomaas, Natal, on Jan. 2, 1949, he collected a nest of this weaver containing two eggs of the host and one of the didric cuckoo.

New to our earlier list of victims is the Zambesi brown-throated weaver (*Ploceus xanthopterus*). A young didric cuckoo was found in a nest of this bird at Karonga, Nyasaland, on February 25 (Benson and Benson, 1949, p. 165).

Also new to the roster of the didric's hosts is the red-winged anaplectes (*Anaplectes rubiginosus*) listed in this capacity in Nyasaland by Benson (1953, p. 35).

The red bishop bird (*Euplectes orix*) was recorded earlier as a frequent victim, but how frequently it suffers from the attention of the parasite has recently been made clear by Reed (1953, pp. 138-140), who found no fewer than 23 parasitized nests in the Transvaal.

The Zanzibar red bishop bird (*Euplectes nigroventris*) may be a host that previously was overlooked. Fischer (1880, p. 190) found a nest of this weaver with a live female didric caught entangled on it. The

nest contained three eggs, of which one was smashed and the others seemed to be *Euplectes* eggs. It must be cautioned that there is no proof of parasitism in this case; the cuckoo may have come to lay there or to eat one of the eggs in the nest.

The fire-crowned bishop bird (*Euplectes hordeacea sylvatica*) does not appear to have been recorded as a victim of the didrie cuckoo until Benson (1953, p. 35) listed it as a host of this parasite in Nyasaland, but without further details. In the Upemba Park, Belgian Congo, Verheyen (1953, p. 315) saw a hen didrie entering a colony of the nominate race of this bishop bird but he did not obtain evidence of any actual parasitism.

The white-winged whydah (*Coliuspasser albonotatus albonotatus*) is suspected of being a host of the didrie in Southern Rhodesia by Edwards, according to Miles (1951, p. 4), but no definite evidence seems to be known.

The golden-breasted bunting (*Emberiza flaviventris*) has been definitely added to the known victims of this cuckoo by Haydock (1950, p. 150; 1951, p. 3) in Northern Rhodesia. He observed nestling didries, one in each of three nests of this bunting, as well as three young didries already out of the nest apparently attended by the buntings.

When discussing the Cape rock bunting (*Fringillaria capensis*) as a host of the didrie, I mentioned (Friedmann, 1949a, p. 177) that although several writers had listed it as such, no localities or other particulars were available. It seems that these authors were copying from one another, and that the original source of them all was Mrs. Barber, who apparently made her observations in the Transvaal. Sharpe's edition of Layard's "Birds of South Africa" (1875, p. 155) appears to contain the first mention of Mrs. Barber's data.

#### EGG LAYING

In my earlier report I stated that there is good evidence to the effect that the didrie hen often, if not regularly, may remove an egg from the nest when laying its own into it. Skead (1952, p. 9) came to a similar conclusion as well, but Reed (1953, pp. 138-140) concluded that the opposite seemed to be the case. Reed studied the didrie's parasitism on the red bishop bird, and found that the cuckoo "does not appear to remove an egg of the . . . host . . . the normal Red Bishop clutch is three eggs and nearly all nests containing cuckoo eggs carried a total of four eggs." While he gives data on some 23 instances in which the red bishop bird was parasitized by the didrie, most of these cases were of nests with young cuckoos; in only six nests does he record four eggs each (three bishop bird eggs and one didrie egg).

Inasmuch as this matter of removing an egg often involves the eating of it by the didrie, it may be noted that Calder (1951, p. 36) watched a hen didrie enter a nest of a thick-billed weaver (*Amblyospiza albifrons*), emerge with an egg in its bill, and then eat the contents. No cuckoo's egg was in the nest when it was examined a few minutes later, but it would seem that this weaver may have been intended as a fosterer. It would not be surprising if someone were to find it to act in this capacity.

In the disputed matter of adaptive similarity between the eggs of the cuckoo and those of its victims, the recently amassed data are just as conflicting as was the older information. Reed noted a definite similarity between didrie eggs in nests of the red bishop bird and those of the host, while Skead found noticeable contrast between didrie eggs and those of the builders in nests of Cape wagtails and Cape weavers.

#### EVICTING HABIT

The evicting habit in this cuckoo still presents unsolved problems, but the following data, subsequent to my earlier account (Friedmann, 1949a, pp. 179-181), are of interest. No one has yet seen a didrie chick in the act of ousting either eggs or young from the nest. The evidence from which eviction is assumed to have taken place is merely the fact that eventually the parasite is usually the sole occupant of the nest. Assuming that the young cuckoo is responsible for the disappearance of the other nest contents, Skead (1952, pp. 7, 9) found that a nestling didrie in a Cape wagtail's nest "tolerated" the two eggs of the host for two days after it hatched, when one egg was found below the nest and the other was out of the nest early the next morning (i. e., after 2½ days). In a Cape weaver's nest there were two weaver's eggs when the didrie hatched; the next day one of the weaver's eggs hatched, but the following day both it and the unhatched egg were gone, leaving the didrie as sole occupant. In a spectacled weaver's nest there was one egg of the host when a didrie hatched; both remained in the nest for two days, after which the cuckoo was the only occupant. From these three examples it appears that 2 or 2½ days may be the usual time for the "eviction" (or disappearance from the nest) of the cuckoo's nest-mates. However, this is by no means universal, as Reed (cit. supra) found in the case of a parasitized nest of the red bishop bird. When the didrie hatched there were two of the host's eggs and one of its chicks in the nest, while four days later the nest contained three chicks of the bishop bird and the young cuckoo. Unfortunately, Reed's observations ended at that point. However, in another nest of the same host species he found a didrie about four days old as the sole occupant. At 1:30 p. m. he placed two eggs of the bishop bird in the nest; by 6 p. m. (4½ hours later)

both of these were out of the nest, the inference being that they were ejected by the cuckoo. Reed's general observations, based not only on these two cases but on many other less detailed instances, are that the didric nestling "appears to eject the eggs or young of its host in all cases because in no single instance were large Didric Cuckoo chicks found with Red Bishop young in the same nest."

Contrary to all the above are the cases observed by Pitman and by Chapin (Friedmann, 1949a, pp. 180-181) in which the cuckoo and its nest-mate grew up together until leaving the nest. The type of experiment tried by Reed should be repeated, with constant observation to see if, and how, ejection is performed.

#### FLEDGLING FEEDING

Another observation of fledgling feeding by a didric cuckoo comes to me from Pike, who saw, in the Transkei area, Cape Province, on December 11, a well grown young didric being fed by an adult male of the same species. This further supports the general conclusion that fledgling feeding is done by the male, and, to this extent, bolsters the thought that fledgling feeding may be only courtship feeding with a grown young being mistaken for a hen by the cock bird.

Additional cases of a male didric feeding another of its kind have been published by Maclaren (1953, p. 167; 1952, pp. 684-685), but the light was poor on all occasions and he was unable to determine if the birds being fed were adult females or fully fledged young.

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STUDIES IN NEOTROPICAL MALLOPHAGA. XVI: BIRD LICE  
OF THE SUBORDER ISCHNOCERA

By M. A. CARRIKER, JR.

The present paper deals with two very interesting groups of Mallophaga parasitic on one of the largest families of Neotropical Passeriformes, the Formicariidae (antbirds). In spite of the fact that this family of birds contains 53 genera and 680 species and subspecies (Peters, Check-List of Birds of the World, 1931), there have been described from it only three species of Mallophaga—two species of *Machaerilaemus* and one species of *Furnaricola* which possibly may have been a straggler from some species of Furnariidae or Dendrocolaptidae.

This family of birds inhabits all varieties of cover ranging from dry, xerophytic scrub to dense, humid jungle and from sea level to timber line all the way from México to Argentina and Chile.

At this point I wish to insert a note respecting the group of Mallophaga for which I erected the genus *Furnaricola* in 1944 and which was placed under the synonymy of *Rallicola* by Hopkins and Clay in 1952 (A Checklist of the Genera and Species of Mallophaga). The species described under *Furnaricola*, and numerous other undescribed specimens in my collection of the same genus are all from hosts belonging to the families Furnariidae and Dendrocolaptidae, with the single exception mentioned above, which was taken on a species of Formicariidae.

A careful examination of the species of this group shows that they are, apparently, closely related to the species of the two new genera

described in this paper that were taken from the Formicariidae. In my opinion they are much nearer to these two genera than to the genus *Rallicola*, in which Hopkins and Clay think they should be placed.

I am not at all reconciled to Miss Clay's theory in attempting to trace the origin and relationship of these species for which sufficient proof seems to be wanting. The fact that they resemble superficially many species of *Rallicola* may very readily be a case of parallel development of two offshoots from entirely different ancestors. It does not seem logical that two families of birds so far apart systematically as the rails and ant birds could possibly have acquired the same genus of mallophagan parasites, either by direct inheritance or secondary infestation. If *Furnaricola* contained but one or two species their presence could be accounted for by secondary infestation, but such could scarcely account for a widespread genus on two families of passerine birds as we have in this case.

I have had in my collection for some time a considerable number of Ischnocera from the ant birds but have never been able satisfactorily to allocate them generically. Since it is clearly evident that they form two closely knit entities which cannot be made to fit into any known genera, I have erected two new genera to receive them.

*Formicaphagus*, new genus, is the larger of the two new genera, containing 15 species, and is parasitic on many and possibly all genera of the Formicariidae except the genus *Formicarius*, on which an entirely different insect is found. I have specimens of this larger genus from 9 genera and 16 species and subspecies of ant birds, ranging from the tiny arboreal genus *Myrmotherula* to the large, terrestrial genus *Pittasoma*.

*Formicaricola*, new genus, the smaller of the two new genera, is erected for the mallophagan species parasitic on birds of the genus *Formicarius*. This smaller genus apparently is restricted to *Formicarius*, since it was taken only on that genus, and no species of the larger genus (*Formicaphagus*, new genus) has been taken on any *Formicarius*. The new genus *Formicaricola* is represented by seven species taken from seven species and subspecies of the avian genus *Formicarius*, ranging from northern México to Bolivia.

The two new genera have certain characteristics in common, but differ very strikingly in others, as will be shown in their characterizations. The species of both genera form remarkably homogenous groups, and no species of either genus has been taken by me on any other family of birds.

The species of both new genera, while resembling each other closely, are separated easily by a combination of various small characters. The male genitalia are especially useful in this respect, since no two

of the 12 species represented by males have similar genitalia.

In all the years of my collecting I have taken no Ischnocera from any Formicariidae other than those included in these two new genera, with but a single exception. The exception is a series of 11 specimens of both sexes of a species of *Sturnidoecus* that were taken on *Batara cinerea excubitor* collected at Samaipata, Bolivia. There is no question as to the host, since I distinctly recollect having removed the lice from the bird before it was skinned. The circumstances were unusual, since it was my first taking of the genus *Batara*.

It therefore seems logical to suppose that these two genera of Mallophaga are the common parasites of the Formicariidae, the one found only on the genus *Formicarius* and the other on all the remaining genera, as far as now known.

The presence of this very distinct genus of Mallophaga on *Formicarius* and the absence of the other genus found on the rest of the family present a problem which the ornithological systematist may very well ponder with care, since there is a remote possibility that *Formicarius* may not be a Formicariidae at all. These birds certainly have a very different appearance in life from all other Formicariidae, although their whistling call-note does resemble a few species of the genus *Grallaria*.

I believe that a very careful study of the anatomy and osteology of this genus of birds should be made, as well as of its nidification. To my knowledge, I have never seen the nest or eggs of any *Formicarius*.

With one exception, all of the species of Mallophaga described in this paper were taken by the author from birds collected by him or his assistants, so that it has been possible to detect most of the obvious cases of "straggling" that inevitably present themselves. In many cases of this so-called "straggling" the true host was easily detected by making a check of the species of birds collected on the same date, but when such measures failed to give a satisfactory solution the lice were discarded in most cases.

All measurements given are in millimeters and decimals thereof, and were made with a properly calibrated eye-piece micrometer. All figures presented are from drawings made by the author, who is responsible for any errors which may later be discovered. The drawings were all made by means of exact measurements taken with the eye-piece micrometer; no "camera lucida" was used.

### ***Formicaphagus*, new genus**

GENOTYPE: *F. picturatus*, new species. Host, *Myrmeciza i. im-maculata*. Small species of Ischnocera parasitic on many genera of the avian family Formicariidae (except the genus *Formicarius*).

This genus seems to be related to the philopteroid group, and resembles superficially the genus *Sturnidoecus*, from which it differs, however, in many important characters, as will be shown.

Head about as wide as long, with circular, expanded temples more or less as wide as the abdomen in the male, slightly less in the female. Preantennal portion of head converges sharply to a narrow, bifid frons, more or less deeply incised. Premarginal carinae usually wide but short, terminating at the preantennal suture encircling the posterior portion of the anterior plate, which is flatly convex and does not extend beyond the entrance to the bucal cavity. The anterior plate is uniformly pigmented, without dividing lines, with half its length extending beyond the tips of the premarginal carinae, and with exposed portion encircled by a narrow hyaline border.

The inner premarginal carinae are well developed, extending from anterior mandibular condyles and base of premarginal nodi to tips of frons. In most of the known species there is a conspicuous, heavily chitinized, oval incrassation on the outer side of these carinae, in median portion of anterior plate. A sharply defined suture cuts diagonally across the premarginal carinae, just in front of nodus, from the margin of the head to a point midway between the mandibular condyles. The temporal carinae (dorsal) are absent, but in all species a well-defined carina curves backward and inward from the premarginal nodus to the posterior mandibular condyle (see figures); the occipital carinae (sternal) are always present, rather narrow, and poorly chitinized, ending usually at anterolateral margin of prothorax. Gular plate large, varying greatly in detail of attachment to prothorax.

Prothorax small, much wider than long, and more or less quadrangular. Pterothorax, with strongly divergent sides, straight to convex, and, with few exceptions, posterior margin produced to a point medially.

Abdomen elongated oval in both sexes, with sharply defined, deeply colored pleurites which are furnished with conspicuous "heads." Tergites lightly chitinized and separated medially; sternites entire but separated from pleurites and almost invisible except for the genital plate and one or two sternites anterior to it. Terminal abdominal segment of female much wider than long, with rounded sides and slightly indented tip. In the male, segment VIII is small, with concave sides and rounded tip. Chaetotaxy of the abdomen (in posterior half) differs in the sexes. In the female there is a sternal row of seven to nine fine setae on each side of segment VIII, in the anterior portion, which point inward and backward and which must not be confused with the pair of heavy spines found in this area in the genus

*Rallicola*. The circular posterior margin of the genital plate of the female is sparsely set with short, fine setae.

The male genitalia are of an exceedingly peculiar type, which seems to be unique. The basal plate is short and rather wide; the parameres very small and globular in shape (see figures); and the mesosome is more strongly developed, with a large penis and rather heavy supporting structures.

REMARKS: The genus *Formicaphagus*, as now known, is an extremely homogenous one, most extraordinarily so, considering the fact that the species comprising it are parasitic on very distinct genera of hosts, but all belonging to a single family. It is possible that some of the forms here described are only subspecifically distinct from some of the others, but no attempt has been made to make such distinctions. A very careful analysis of their structures shows an amazing number of small differences between them. The genitalia of all of the known males are decidedly different, a very significant feature. Considering these facts it has seemed best to classify them all as distinct species until more material has been assembled from the many species of the host family.

*Formicaphagus picturatus*, new species

FIGURES 1,a,b; 4,e

TYPES: Male and female adults from *Myrmeciza i. immaculata* (La Fresnaye) collected by the author at Bellavista, Santander N., Colombia, July 4, 1943 (USNM).

DIAGNOSIS: The head as long as wide in male (0.445), wider than long in female ( $0.467 \times 0.48$ ). The premarginal carinae are wide, with large nodi; anterior plate rather small, widest at tips of premarginal carinae then converging posteriorly with straight sides; preantennary margin of head concave.

Sides of prothorax and pterothorax nearly straight, the latter with sides strongly divergent and posterior margin with straight sides running to an acute median point.

The abdominal pleurites are wider in the female, both dorsally and ventrally, and are less pitchy black dorsally; the "heads" are much longer in the female, especially the ventral portion. Whole abdomen very clear (excepting pleurites), with tergites almost invisible; the only visible sternites are the genital plate and sternite V, the genital plate covering the median portion of sternites VI to VIII.

In the male genitalia the basal plate tapers from near basal portion to the narrowly rounded tip; the parameres are of medium size, encircled by a strongly chitinized carina, and the component parts of the mesosome are slender and more delicate than in most species of the genus.

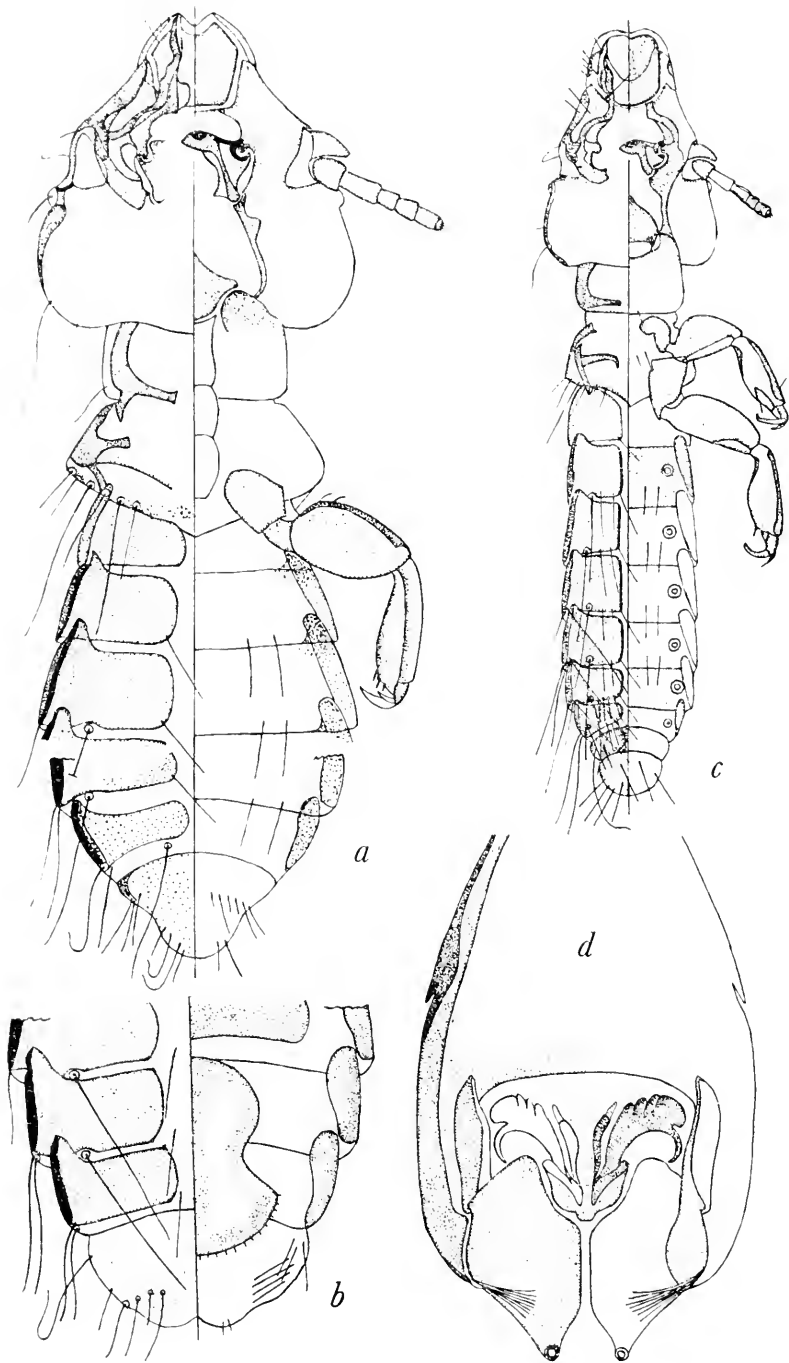


FIGURE 1.—*a, b*, *Formicaphagus picturatus*: *a*, head, thorax, and portions of abdomen of male; *b*, tip of abdomen of female. *c*, *Formicicola analoides*, body of male. *d*, *Formicicola beni*, genitalia of male.



For measurements see table 1 (p. 429). It has not seemed necessary to present measurements of the male genitalia.

The species is represented only by the male holotype and female allotype.

*Formicaphagus laemostictus*, new species

FIGURE 2,a

TYPE: Female adult from *Myrmeciza laemosticta bolivari* de Schauensee, collected by the author at Puerto Valdivia, Antioquia, Colombia, May 4, 1948 (USNM).

DIAGNOSIS: One of the larger species (body,  $1.89 \times .52$ ; head,  $0.495 \times 0.485$ ), with head longer than wide, the reverse of *F. picturatus*. The preantennal margin of head is straight; the anterior plate is much wider in anterior portion, where the sides are convex, while in posterior portion the sides are straight and parallel; a small, darker colored shield covers anterior portion, this character being present in but three of the known species of the genus.

The premarginal carinae are VERY WIDE, and there are well-developed postmarginal carinae not present in all species.

The sides of both thoracic segments straight, with pterothorax narrower and less divergent than in *picturatus* (0.395 against 0.412); sides of posterior margin of pterothorax straight, with acute median point.

Abdomen rather long and slender ( $1.16 \times 0.52$ ); pleurites pitchy black (except pleurite I) and of medium width, with "heads" very short on dorsal portion and long on the ventral portion. Tergites and sternites faintly pigmented except genital plate and sternite V; setae along posterior margin of genital plate short and peglike. The patch of setae at each side of sternite VIII consists of a row of seven setae set parallel to margin, and pointing diagonally backward and inward, and with two others between this line of setae and the margin of segment, pointing backward.

The species is represented by the male holotype, one female paratype, and one female from another individual of the type host collected at Zaragoza, Antioquia, Colombia.

*Formicaphagus magnus*, new species

FIGURE 2,b

TYPE: Female adult from *Myrmeciza laemosticta palliata* Todd, collected by the author at La Palmita, Norte de Santander, Colombia, Aug. 14, 1916 (author's collection).

DIAGNOSIS: Distinguished by the large head, very large anterior plate, partially pigmented premarginal carinae and nodi, and narrow, faintly pigmented abdominal pleurites. The head is longer than

wide ( $0.553 \times 0.532$ ); the anterior plate of same shape as in *laemostictus* but much larger and without anterior shield; the premarginal carinae are wide but pigmented only along the inner margin, while the nodi are chitinized in posterior portion only. The incrassations on inner carinae, over anterior plate, are smaller than usual; the pre-antennal margins of head slightly undulating, with sides of anterior plate extending latterly beyond line of head; postmarginal carinae also present, but differing in pattern from those of *laemostictus* (see fig. 2,b).

Prothorax with sides flatly convex; pterothorax very wide (0.47) with convex sides, that portion posterior to the lateral angles shortened and with sides straight to rounded median tip (fig. 2,b).

Abdominal pleurites narrow, ventral portion scarcely wider than dorsal; "heads" short, tapering to a slender point which curves inward and backward, forming a semicircle. Structure of tergites and sternites obscured by foreign matter. Setae along posterior margin of genital plate short and thick; ten ventral setae on sides of sternite VIII, paralleling lateral margin, and two more between this line and the margin, all pointing diagonally backward and inward and all longer than those of *laemostictus*.

The species is represented by the female holotype only.

***Formicaphagus angustifrons*, new species**

FIGURES 2,d; 5,c; 6,d

TYPES: Male and female adults from *Myrmeciza h. hemimelaena* Selater, collected by the author at Santa Ana, Rio Coroico, Bolivia, July 21, 1934 (author's collection).

DIAGNOSIS: One of the smallest species of the genus (body of male,  $1.25 \times 40$ ; of female,  $1.40 \times 0.40$ ; head of male,  $0.39 \times 0.39$ ; of female,  $0.417 \times 0.417$ ); the abdomen of the female is longer but no wider than in the male.

Temples rounded; occipital margin deeply reentering at sides of prothorax, but occiput convex; frons very narrow; preantennal margins slightly concave; anterior plate small, widest in posterior portion and converging sharply to the narrow tips; premarginal carinae narrow, as well as the inner carinae which support the anterior plate; incrassations elongated and not reaching to the lateral margins of the plate; no postmarginal carinae; eye very small, with short, thickened seta at anterior corner. (In the figure of the head of this species the temporal and occipital carinae occupy reversed positions.)

Thoracic segments small, with sides slightly convex; pterothorax only 0.31 in width in the female and 0.29 in male; posterior margins straight and median point rounded.

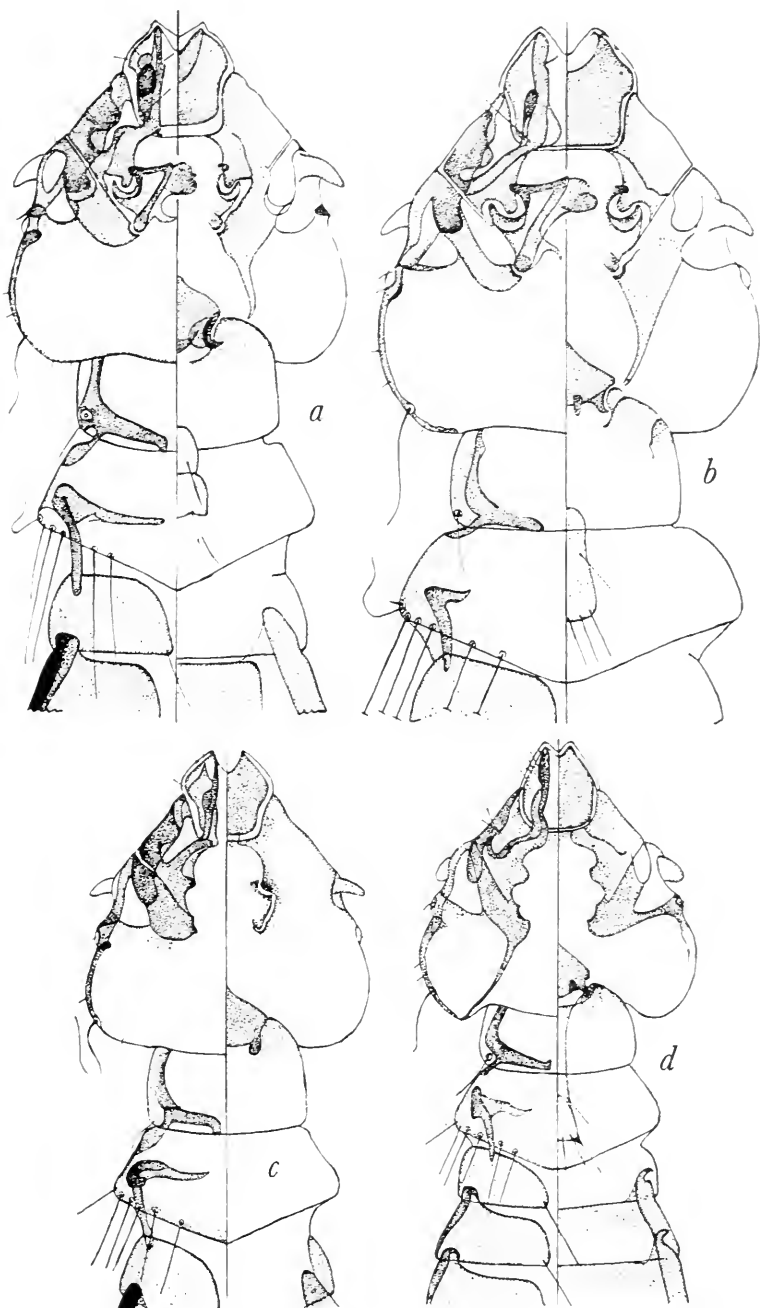


FIGURE 2.—Head, thorax, and certain abdominal segments: *a*, *Formicaphagus laemosiictus*, female (segments I, II); *b*, *F. magnus*, female (segment I); *c*, *F. peruvianus*, male (segment I); *d*, *F. angustifrons*, male (segments I–III).

Abdomen quite clear, but tergites and sternites more clearly defined than in many species; pleurites dark brown, blacker in the male, and with ventral portion twice the width of the dorsal (more than twice in female); pleurites in segment I well defined but not deeply pigmented; the "heads" are short and rounded on dorsal portion, longer on ventral portion and with the attenuated tips curving outward.

The marginal setae of the genital plate in female are longer and set closer together than in the preceding species; the setae at posterior, inner corner of tergites are very long, as well as the single, pustulated seta on posterior margin of tergites III to VII, just inside the pleurites. The sternal setae at sides of VIII are also long and slender, some as long as width of segment, and average seven in number.

In the male the setae of the abdominal tergites and of segment VIII are also unusually long; the genitalia are small, the basal plate being short with broad, rounded apical end; parameres globular, with narrow, deeply pigmented marginal carina; mesosome very simple, but portions not clearly visible (fig. 6,d). The species is represented by male holotype, female allotype, and one male and five female paratypes.

*Formicaphagus huilae*, new species

FIGURES 4,a; 6,h

TYPE: Female adult from *Myrmeciza longipes boucardi* Berlepsch, collected by the author at La Plata, Huila, Colombia, Apr. 10, 1952 (USNM).

DIAGNOSIS: A medium sized species (body  $1.60 \times 0.43$ ; head  $0.425 \times 0.423$ ), strikingly colored. The head, thorax, and legs are pale, clear brown; the carinae of head and legs darker brown, while those of thorax are almost pitchy black; the abdomen is uniformly translucent, excepting the pleurites, genital plate, and lateral margins of segment VIII; the pleurites are rather wide, pitchy black, slightly wider ventrally in posterior portion, and sharply defined on inner side; the "heads" are short dorsally and bluntly pointed, but twice as long ventrally and faintly colored; genital plate and margins of segment VIII pale brown; sternite V is faintly visible, and all sternites are clearly and widely separated from pleurites. The setae of genital plate are normal, rather abundant, and thickened basally; ventral setae on sides of segment VIII are rather short and slender, six in the row parallel to margin and pointing inward, with two near margin, pointing backward.

The species is represented by the female holotype and two female paratypes.

FIGURE 3.—Head, thorax, and certain abdominal segments of female: a, *Formicaphagus splendidus* (segment I); b, *F. grallariae* (segments I–III); c, *F. minutus* (segments I–III); d, *F. thoracicus* (segments I, II).

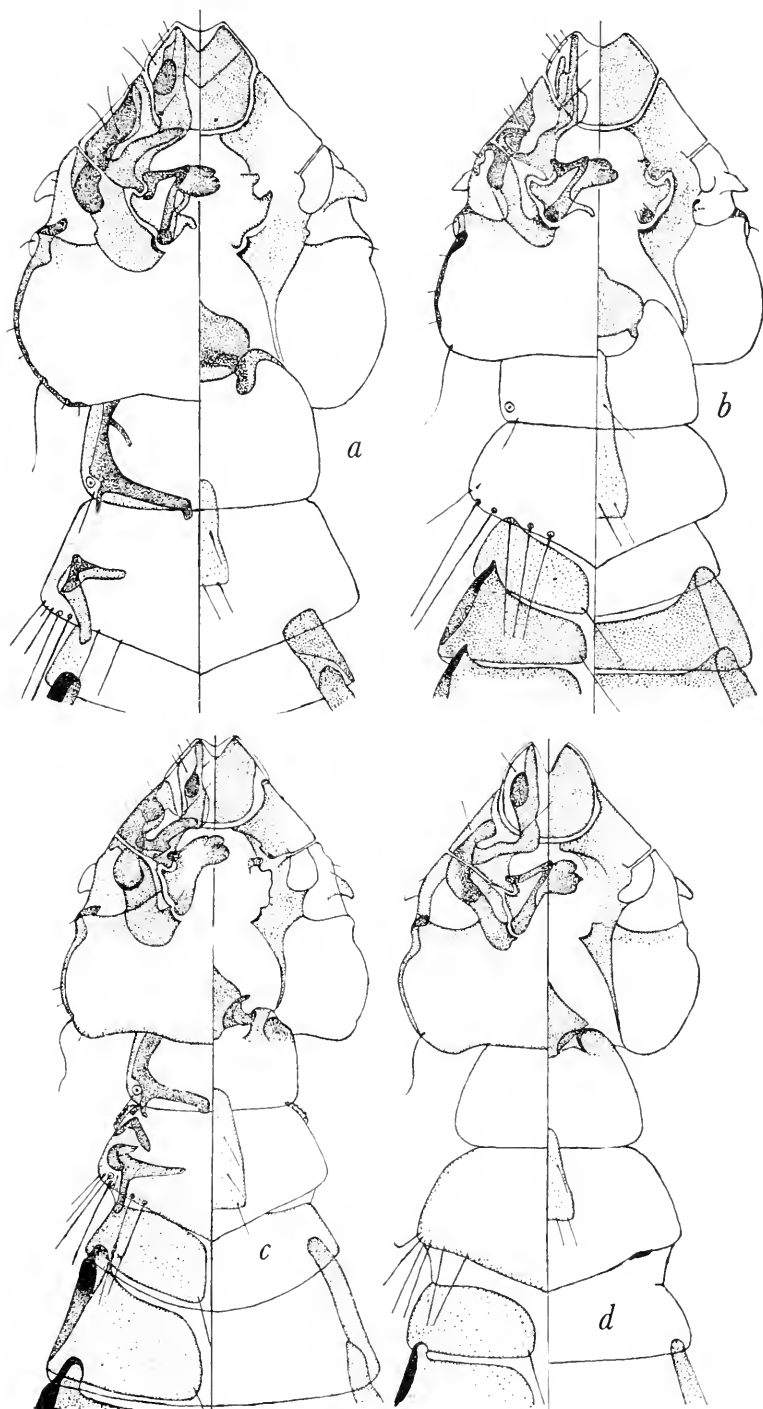


FIGURE 3.—Explanation on facing page.

*Formicaphagus latifrons*, new species

FIGURES 4,b; 5,h

TYPE: Female adult from *Cercomacra n. nigricans* Selater, collected by the author at Río Vieja, Bolívar, Colombia, Feb. 24, 1947 (USNM).

DIAGNOSIS: One of the larger species, equal in size to *F. magnus*, with practically the same head and body measurements except width of head at conl, which is less (0.41 against 0.45).

The head is wide at tips of premarginal carinae, with preantennary margin sinuate; anterior plate longer than wide, widest at tips of premarginal carinae, from which point sides converge to rounded tips of frons and backward to posterior margin. Premarginal carinae wide, with inner margin irregular in outline; nodi large, with posterior half much more deeply pigmented; inner carinae, which support anterior plate, are wide, covering almost half of that plate and with the large incrassations reaching the lateral margins. Postmarginal carinae present but faintly colored; eyes small, with short seta; attachment of gular plate to prothorax somewhat unusual (fig. 4,b).

Head, legs, and thorax pale, translucent brown, with carinae darker brown; abdomen clear, except the large pleurites which are pitchy black dorsally and dark umber brown ventrally, the ventral portion being much wider than the dorsal portion and with undulating inner margin; "heads" short on dorsum, very long on ventral face, and clear brown. Tergites uncolored, with only genital plate and sternite V visible; lateral portion of VIII light brown. Abdominal setae unusually short, those of genital plate normal; the lateral, sternal setae of VIII are eight in number, short, and all point inward and slightly backward.

The species is represented by the female holotype only.

There is a single female from *Cercomacra t. tyrannina*, collected at Santa Rosa, Bolívar, Colombia, which is so close to the type of *latifrons* that it seems useless to attempt its separation. All measurements are practically the same except width of head at preantennary suture, which is greater (0.38 against 0.365), and abdomen shorter and narrower (never a reliable measurement). The number of ventral setae on segment VIII is the same. I have, therefore, identified this female as *F. latifrons*.

*Formicaphagus clypeatus*, new species

FIGURES 4,c; 5,d; 6,c

TYPES: Male and female adults from *Pernostola leucostigma brunnei-ceps* (Zimmer), collected by the author at La Pampa, Perú, July 5, 1931 (author's collection).

DIAGNOSIS: One of the smaller species (body,  $1.78 \times 0.55$ ; head,  $0.445 \times 0.445$ ). Body coloring the same as in preceding species.

The preantennary margin straight; hyaline border of anterior plate wider than usual and with much more than half of the plate extending beyond the tips of the premarginal carinae (usually half or less); this plate is longer than wide, with deeply incised, wide frons, and

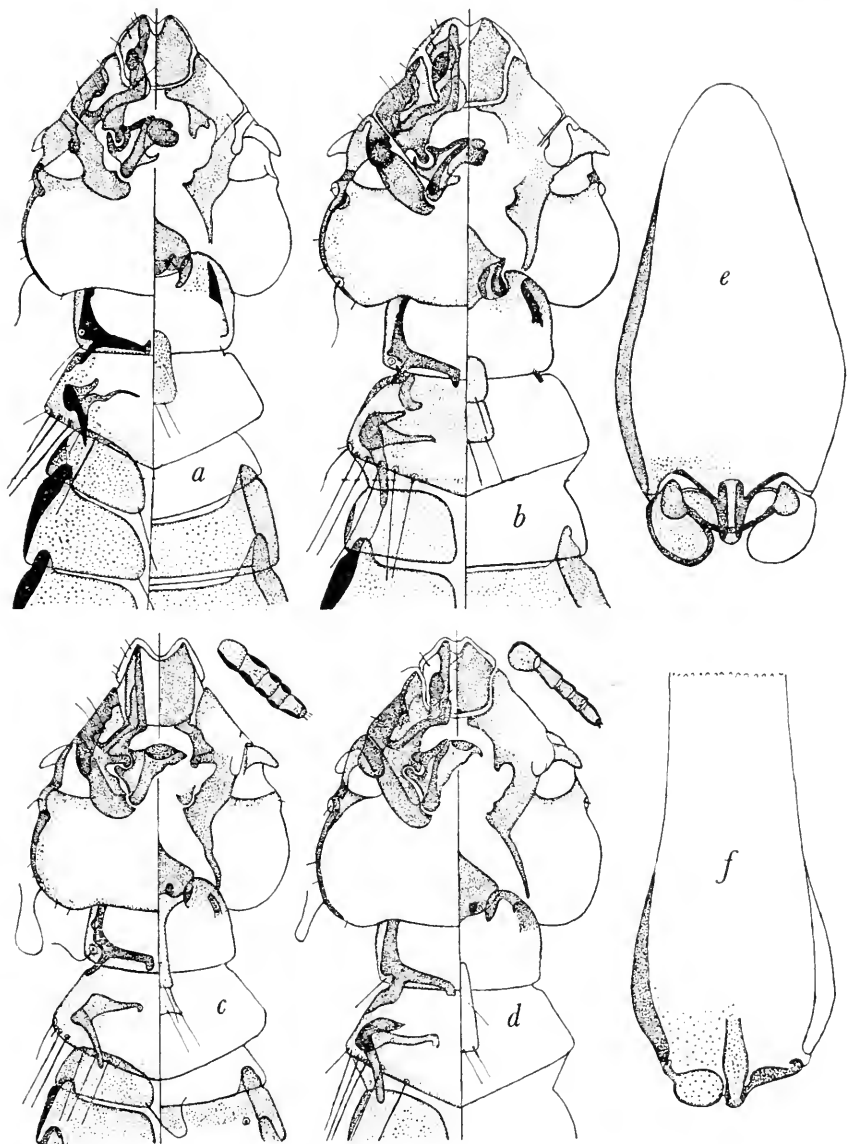


FIGURE 4.—a-d, Head, thorax, and certain abdominal segments: a, *Formicaphagus huilae*, female (segments I-III); b, *F. latifrons*, female (segments I, II); c, *F. clypeatus*, male (segments I, II); d, *F. bolivianus*, female (segment I). e, f, Male genitalia: e, *F. picturatus*; f, *F. minutus*.

with sides straight and parallel for greater portion; the inner carinae are unusually narrow, very straight in anterior portion and lack entirely the large incassation so prominent in most species (fig. 4,c); antennae unusually thick (compare *c* and *d* of fig. 4; *d* being about normal); eye obsolete, but setae present; conic small.

Prothorax small, especially short ( $0.13 \times 0.26$ ); pterothorax with straight, divergent sides, broadly rounded lateral angles, and sides of posterior margin flatly convex with rounded median tip.

Color of abdomen as in preceding species, with pleurites of average size, largely pitchy black dorsally, and but slightly wider ventrally, more so in posterior portion; "heads" short and bluntly pointed on dorsal face but much longer ventrally, some of them curving outward apically.

Abdominal setae shorter than average; the ventral patches on sides of sternite VIII average nine<sup>1</sup> in number, are short, and most of them point backward; there are also five dorsal setae in a transverse row on each side of segment VIII, all set in small, clear pustules. These latter setae are present in all species, but the number varies (usually three) with inner one always the longest.

The species is represented by the male holotype, female allotype, and one male paratype.

***Formicaphagus peruvianus*, new species**

FIGURES 2,c; 6,a

TYPE: Male adult from *Myrmotherula schisticolor interior* (Chapman), collected by the author at Eneñas, Perú, Mar. 3, 1930 (author's collection.)

DIAGNOSIS: One of the group with small head, only *minutus* and *angustifrons* having smaller ( $0.412 \times 0.402$ ). Differs from *angustifrons* in having whole occipital margin of head convex instead of deeply emarginate at sides of occiput; the anterior plate is much wider in the anterior portion than in the posterior portion, the reverse of *angustifrons* (see figs. 2,c and 2,d); the head is much wider at conic ( $0.337$  against  $0.295$ ); pterothorax slightly larger than both species mentioned above, with sides slightly concave and posterior margin straight. Abdomen longer than in *angustifrons* and *minutus*, and wider than in *angustifrons*; color normal; pleurites large and pitchy black dorsally, with sternal portion considerably wider; "heads" of pleurites short both dorsally and ventrally, the ventral portion being weakly pigmented.

In the genitalia the basal plate is very similar to that of *clypeatus* and *angustifrons*, but longer than in latter; the parameres are similar in size and shape to those of *angustifrons* but lack the dark marginal

<sup>1</sup> Segments VII and VIII are fused so closely that the line of fusion is not always visible. The setae are on segment VIII.



carina; mesosome very different, resembling somewhat that of *picturatus* but with a much smaller penis.

The species is represented by a single specimen, the male holotype.

*Formicaphagus minutus*, new species

FIGURES 3,c; 4,f; 6,g

**TYPES:** Male and female adults from *Herpsilochmus rufomarginatus frater* Sclater and Salvin, collected by the author at Upata, Venezuela, Feb. 22, 1910 (author's collection).

**DIAGNOSIS:** One of the group of small species, with body larger than *angustifrons* and *clypeatus*, but head smaller than in the latter (male,  $0.402 \times 0.38$  against  $0.434 \times 0.412$ ; female,  $0.423 \times 0.434$  against  $0.434 \times 0.434$ ); the head is longer than wide in the male and wider than long in the female.

Sides of head, between conic and tips of frons, forming a straight line; anterior plate small and similar to that of *thoracicus* except that frons is wider and the incassations smaller; premarginal carinae wide and short, with nodi large and circular; no postmarginal carinae; the carinae uniting premarginal nodi and posterior mandibular condyles very wide.

Prothorax short, with sides flatly convex and almost parallel; pterothorax small, being especially narrow ( $0.16 \times 0.31$ ).

Abdomen of normal shape and color, the pleurites well developed, about equal in the sexes and pitchy black dorsally, with ventral portion wider and paler; all setae rather short and slender, except those around posterior margin of genital plate which are slightly longer than usual; the ventral patches of setae on each side of segment VIII contain a longitudinal row of seven setae, with two smaller ones near margin which point backward.

The male genitalia are quite different from the other known species, with basal plate much longer, with wide, heavily chitinized marginal carinae on swollen basal portion; the parameres are oval in shape, very similar to those of *peruvianus* but without marginal carinae; the mesosome is very rudimentary, merely an undulating transverse bar which supports an unusually large penis.

The species is represented by the female holotype, male allotype, and one female paratype.

*Formicaphagus thoracicus*, new species

FIGURE 3,d

**TYPE:** Female adult from *Gymnopathys leucaspis bicolor* (Lawrence), collected by the author at Quibdó, El Chocó, Colombia, Mar. 13, 1918 (author's collection).

DIAGNOSIS: Sides of head straight between conic and anterior plate, which is circular in shape, with deeply incised frons, wide supporting carinae, and large incrassations; premarginal carinae with marginal half faintly pigmented, also outer portion of nodi, which are semi-circular in shape, the tips curving inward; postmarginal carinae present but pale.

Prothorax narrower in anterior portion, with convex, divergent sides (an unusual shape); pterothorax large ( $0.21 \times 0.36$ ), with rounded sides and short posterior portion.

The abdomen is large ( $1.21 \times 0.61$ ), with narrow pleurites, blackish dorsally and wider ventrally in anterior and posterior portions.

The type, and only specimen, is in rather poor condition, having been demounted for clearing, and with much of the chaetotaxy missing, so that the number of setae in ventral patches of sternite VIII cannot be determined.

The species may be distinguished by the unusual shape of the anterior plate, the carinae of the head, and the shape of the thoracic segments.

*Formicaphagus brevifrons*, new species

FIGURE 5,a; 6,e

TYPES: Male and female adults from *Pyriglena leucoptera* (Vieillot), collected by Dr. Werneck at Serra de Angra, State of Rio de Janeiro, Brazil (Hopkins collection).

DIAGNOSIS: The largest of the known species of the genus (female,  $2.12 \times 0.67$ , with abdomen  $1.34$ ; male,  $1.54 \times 0.49$ ). Head wider than long in both sexes, with swollen temples, and in female much wider at base of conic.

Anterior plate wider than long, wider at tips of premarginal carinae; frons narrow and median incision shallow; the premarginal carinae are of unusual shape and rather complicated for description (see fig. 5,a); carinae connecting premarginal nodi with posterior mandibular condyles narrow.

Prothorax with sides and posterior margin convex; pterothorax with sides convex and strongly divergent; each side of posterior margin concave and with median point rounded, this character more pronounced in the male.

Abdomen strongly oval in both sexes, with wide pleurites, the light brown ventral portion being more than twice the width of the pitchy black dorsal portion.

The tergites are but slightly chitinized, but sternites IV and V are much more deeply colored than usual.

The chaetotaxy of the entire body is unusually short and coarse, and blackish in color; the patches on each side of segment VIII are

short and coarse, with irregular longitudinal line of six to seven, and one outside the line.

The genitalia of the male allotype, the only male, is not clearly visible due to a covering of extraneous matter, but it seems to be as

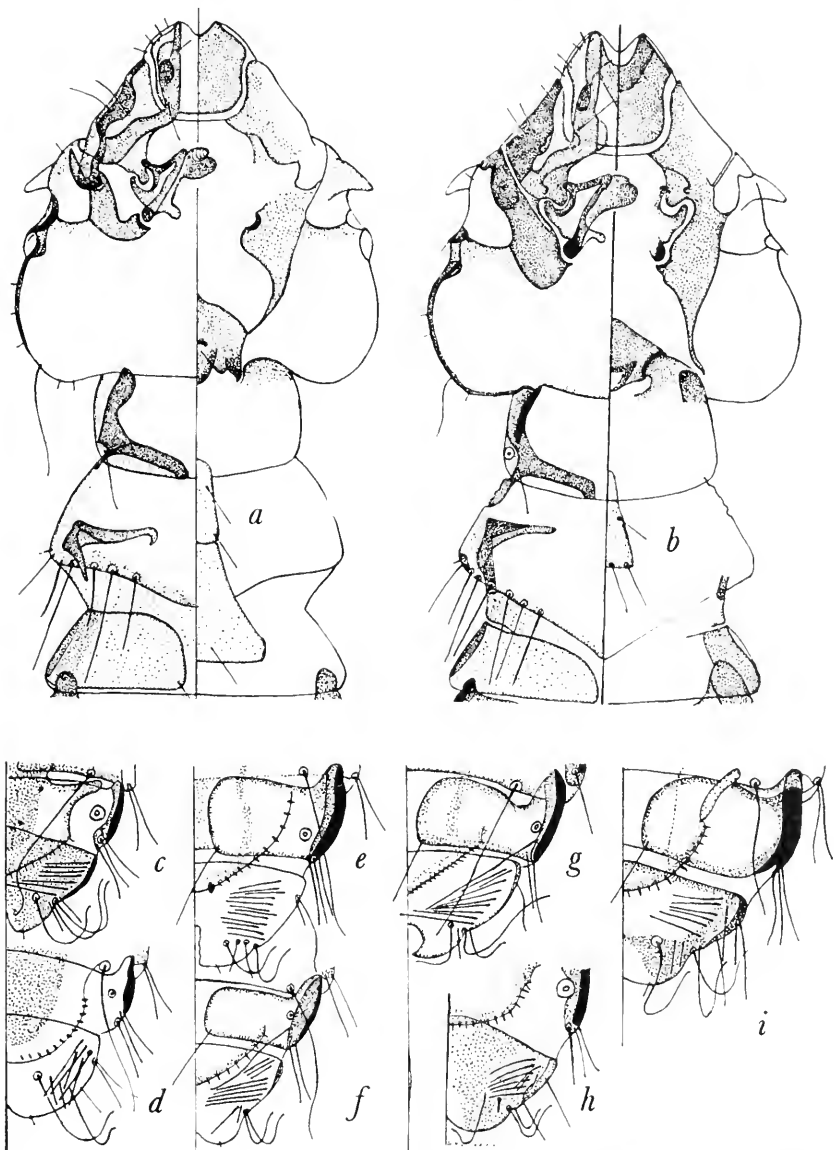


FIGURE 5.—*a, b*, Head, thorax, and abdominal segment I: *a*, *Formicaphagus brevifrons*, female; *b*, *F. pittasomae*, female. *c-i*, Dorsosternal view of tip of female abdomen: *c*, *F. angustifrons*; *d*, *F. clypeatus*; *e*, *F. bolivianus*; *f*, *F. grallariae*; *g*, *F. splendidus*; *h*, *F. latifrons*; *i*, *F. pittasomae*.

shown in figure 6,e, although the shape of the parameres, if correct, is very unusual.

In addition to the female holotype there is one female paratype.

***Formicaphagus bolivianus*, new species**

FIGURES 4,d; 5,e

TYPE: Female adult from *Myrmotherula axillaris fresnayana* (d'Orbigny), collected by the author at Santa Ana, Río Coroico, Bolivia, July 26, 1934 (author's collection).

DIAGNOSIS: A medium sized species with head as wide as long (0.445) and somewhat triangular in shape; the preantennal margin irregular in outline (fig. 4,d); frons very narrow, with scarcely any median depression; anterior plate small, with sides swollen latterly at tips of premarginal carinae and with less than half its length exposed. Premarginal carinae and nodi wide and strongly pigmented; the inner carinae supporting the anterior plate narrow, but incrassations quite large; conic very small, with greater portion under head; eye very minute (shown too large in figure); postmarginal carinae present but poorly pigmented.

Prothorax rather large ( $0.13 \times 0.26$ ), with slightly convex sides; pterothorax small ( $0.22 \times 0.37$ ), with lateral and posterior margins perfectly straight. Abdomen normal, with rather narrow pleurites, pitchy black above, brown and slightly wider below; dorsal "heads" short and bluntly pointed, ventral "heads" much longer and paler; genital sternite rather small and well pigmented but sternites IV and V almost invisible; posterior margin of genital plate an open V-shape, with short, thick setae; the setae of ventral patches on each side of segment VIII unusually abundant, there being eight in the longitudinal row and a cluster of four in anterior portion of segment, all of which are short and most point towards the rear in the holotype, but in the female paratype they are as shown in figure 5,e, being longer than in the type specimen.

***Formicaphagus grillariae*, new species**

FIGURES 3,b; 5,f; 6,f

TYPES: Male and female adults from *Grallaria perspicillata intermedia* Ridgway, collected by the author at El Hogar, Costa Rica, Aug. 28, 1906 (author's collection).

DIAGNOSIS: A species of medium size, with head slightly longer than wide in both sexes, and with female not much larger than male. The entire body is clear, pale brown, the abdomen slightly paler, with tergites and sternites clearly defined.

The head, back of conic, has a rather squarish appearance but from the conic the sides converge sharply in a straight line to tips of frons,

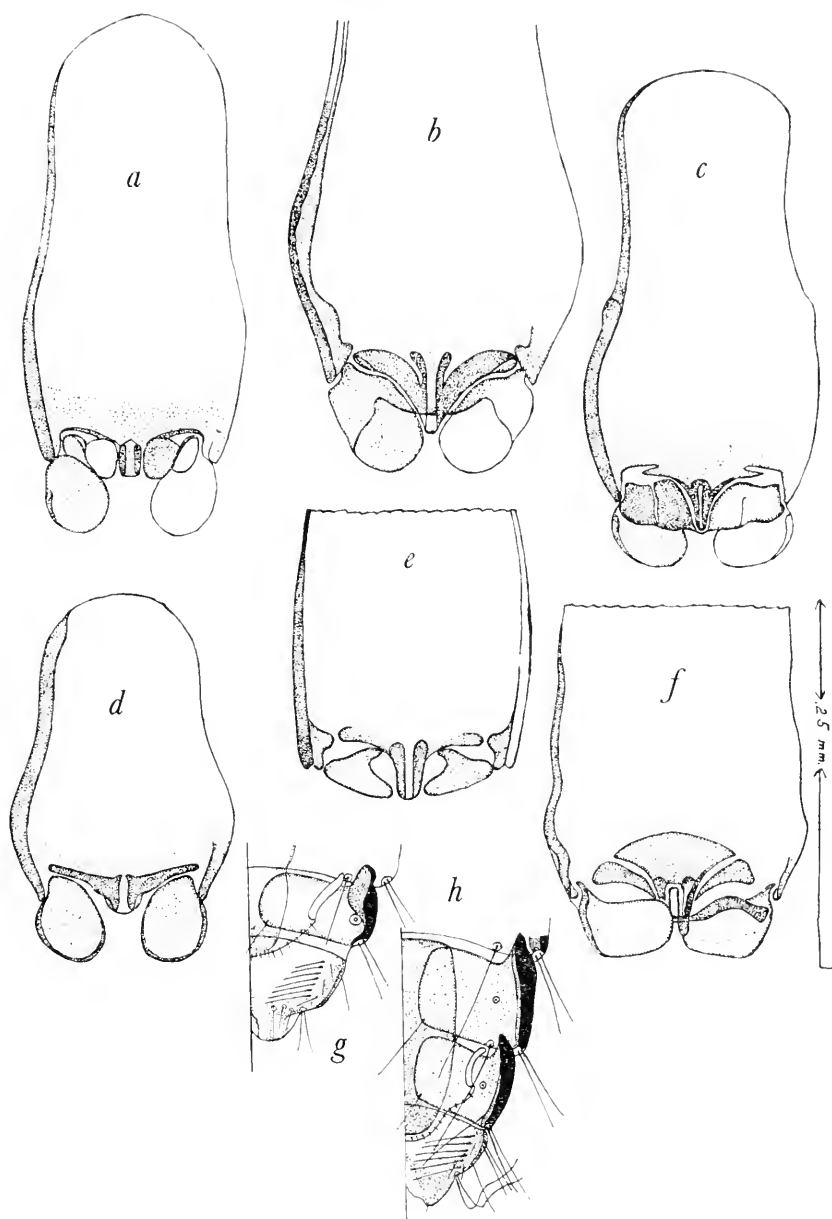


FIGURE 6.—a-f, Male genitalia: a, *Formicaphagus peruvianus*; b, *F. pittasomae*; c, *F. clypeatus*; d, *F. angustifrons*; e, *F. brevifrons*; f, *F. grallariae*. g-h, Tip of abdomen, female: g, *F. minutus*; h, *F. huilae*.

which is of medium width and with shallow emargination. The anterior plate is wider than long, with sides converging both forward and backward from tips of premarginal carinae (fig. 3,*b*); the inner carinae are narrow, widely separated on anterior plate; only the tips of the coni are visible from above; eye small but with seta short and thick.

Prothorax rather narrow (male, 0.34; female, 0.37), with convex sides and posterior margin slightly concave.

The pleurites are narrow dorsally and dark brown, but three times as wide ventrally and not much paler; the dorsal "heads" taper to a slender point, curving inward more noticeably in the male, while the ventral portion is longer, bluntly pointed, and faintly pigmented.

The abdominal chaetotaxy is quite long, especially the patch of eight setae on each side of ventral face of segment VIII that extend more than half way across the segment. Posterior margin of genital plate is V-shaped, rather short, and with setae widely spaced.

In the male, segment VIII is unusually large, with sides straight to the rounded tip. The genitalia are quite distinctive and need no description (fig. 6,*f*).

The species is represented by the female holotype, male allotype, and one male paratype.

***Formicaphagus splendidus*, new species**

FIGURES 3,*a*; 5,*g*

TYPE: Female adult from *Pittasoma michleri zeledoni* Ridgway, collected by the author at Río Sicsola, Panamá,<sup>2</sup> Sept. 10, 1904 (author's collection).

DIAGNOSIS: The body and head are almost the same size as the females of *magnus* (body,  $1.95 \times 0.62$ ; head,  $0.55 \times 0.532$ ), thus being one of the largest known species.

The temples are slightly swollen; the preantennal margins of head form almost straight lines (slightly concave) from coni to tips of frons, which is of medium width and shallow emargination. Anterior plate as wide as long, slightly expanded laterally at middle and with a wide, V-shaped, darker band across anterior portion (fig. 3,*a*). The inner carinae are narrow basally but wide over anterior plate, with large incrassations; eye prominent, with seta short and thick.

Prothorax large ( $0.21 \times 0.33$ ) with convex sides; pterothorax of medium size, with *straight sides and posterior margins* and with lateral angles narrowly rounded. Abdominal sclerites normal; dorsal face of pleurites narrow and black, ventral face twice as wide as dorsal face and brown; tergites set closely together, both transversely and longitudinally. Segment VIII unusually short and wide; ventral

<sup>2</sup> This host was collected on the west side of the Río Sicsola in territory which at that time belonged to Costa Rica but has since been ceded to Panamá.

setae at sides 9-10 in number, all pointing inward and of various lengths, the anterior ones the shorter. Posterior margin of genital plate an open V-shape, set with numerous short, fine setae (fig. 5,g).

The species is represented by the female holotype and two female paratypes.

*Formicaphagus pittasomae*, new species

FIGURES 5,b,i; 6,b

Types: Male and female adults from *Pittasoma rufipileatum rosenbergi* Hellmayr, collected by the author at Pavarondocito, Antioquia, Colombia, May 19, 1950 (USNM).

DIAGNOSIS: A handsome insect of an almost uniformly translucent brown color, sharply defined, dark brown carinae on head and thorax, and black pleurites, but with abdomen paler than head.

It is one of the larger species, the male being the largest known of that sex ( $1.75 \times 0.575$ ); the head of the female is almost equal in length to that of *magnus* and *splendidus*, but is wider ( $0.542 \times 0.553$  against  $0.553 \times 0.532$ ).

Posterior to the conic the head has a quadrangular appearance, with the slightly concave sides of anterior portion converging sharply to the narrow frons; anterior plate longer than wide, very similar to that of *splendidus*; in fact, the whole insect resembles that species, differing as follows: Anterior plate slightly longer; the inner carinae which support it are much narrower, with smaller incassations, and there is an oval projection on inner side of these carinae at base of

TABLE 1.—Measurements (in millimeters) of the species of *Formicaphagus*

Species	Sex	Body length	Head			Prothorax		Pterothorax		Abdomen	
			Length	Width	Width at conl	Length	Width	Length	Width	Length	Width
<i>picturatus</i>	♂	1.49	0.445	0.445	0.337	0.163	0.26	0.197	0.347	0.825	0.456
		2.03	.467	.48	.347	.163	.29	.23	.412	1.11	.52
<i>laemostictus</i>	♂	1.89	.495	.485	.40	.195	.29	.24	.395	1.16	.52
<i>magnus</i>	♂	1.93	.553	.532	.445	.20	.326	.255	.467	1.12	.597
<i>angustifrons</i>	♂	1.25	.393	.391	.295	.11	.217	.152	.293	.673	.402
		1.40	.417	.417	.303	.13	.228	.163	.314	.81	.395
<i>hvilae</i>	♂	1.60	.425	.423	.325	.16	.255	.195	.347	.98	.434
<i>latifrons</i>	♂	1.91	.467	.475	.365	.17	.27	.18	.39	1.20	.567
<i>peruvianus</i>	♂	1.53	.412	.402	.337	.14	.23	.195	.326	.89	.445
<i>clypeatus</i>	♂	1.31	.434	.412	.325	.152	.24	.195	.337	.694	.434
		1.44	.434	.434	.337	.163	.23	.195	.35	.781	.477
<i>thoracicus</i>	♂	1.95	.46	.44	.37	.163	.27	.21	.36	1.21	.61
<i>minutus</i>	♂	1.41	.402	.38	.31	.147	.228	.163	.314	.803	.452
		1.68	.423	.434	.345	.155	.244	.185	.326	1.02	.53
<i>brevifrons</i>	♂	1.54	.434	.445	.325	.15	.27	.195	.38	.846	.488
		2.12	.50	.542	.39	.185	.314	.26	.445	1.34	.673
<i>bolivianus</i>	♂	1.78	.445	.445	.337	.13	.26	.228	.37	1.13	.547
<i>grallariae</i>	♂	1.46	.445	.434	.326	.163	.26	.195	.337	.785	.467
		1.57	.477	.467	.358	.163	.285	.22	.37	.90	.51
<i>splendidus</i>	♂	1.95	.55	.532	.41	.217	.33	.26	.445	1.13	.62
<i>pittasomae</i>	♀	1.74	.52	.516	.39	.185	.303	.217	.402	.992	.575

anterior plate, a character absent in *splendidus* but present in *grallariae* and *magnus*.

The premarginal carinae are wide in *pittasomae* and the pigmentation extends uniformly to the margin of head (figs. 3,a; 5,b); the manner of attachment of the prothorax to the gular plate is entirely different: carinae of the prothorax decidedly distinct; and there is more contrast of color in the abdomen, the ground-color being clearer and the pleurites blacker. The posterior margin of the genital plate of female in *splendidus* is an open V, with closely set marginal setae, while in *pittasomae* the plate is circular and the setae are longer, coarser, and fewer in number. The patches of setae at sides of sternite VIII in *splendidus* contain 9 setae, all pointing inward, while in the present species there are only 6 setae pointing inward, and 1 backward, near margin.

The male genitalia do not resemble those of any of the known males, and a description seems unnecessary (fig. 6,b).

### *Formicaricola*, new genus

Genotype: *F. analoides*, new species. Host, *Formicarius analis saturatus*. Medium sized Ischnocera parasitic on the avian genus *Formicarius* only. Represented by seven species taken from seven species and subspecies of the host genus. In certain characters this genus resembles the preceding one, but after very careful comparison I find it impossible to classify them as congeneric. Species of this genus have a superficial resemblance to *Multicola* and to some of the *Furnaricola* and *Rallicola* but they differ radically from those genera in structure of head and male genitalia, while the females lack the heavy sternal spines in segment VIII so characteristic of *Rallicola*.

I am fully aware that it is not good policy to erect a genus for a group of Mallophaga which are parasitic on a single genus of birds, but in this case there seems to be no alternative, as with the Menoponidae of the genus *Odontophorus* (Phasianidae).

The present genus differs from *Formicaphagus* as follows: Abdomen longer and more slender, nearly parallel-sided; segment VIII of female with sides straight and converging to a deeply incised, bifid tip.

Head much longer than wide; premarginal carinae continued beyond the preantennal suture, to middle of anterior plate; anterior plate more or less quadrangular, with rounded corners and with anterior margin usually as wide as posterior and slightly concave, while posterior margin is flatly convex and never extends beyond entrance to bucal cavity as in *Formicaphagus*.

No trace of the diagonal suture across premarginal carinae in front of nodus; the temporal and occipital carinae are as in *Formicaphagus* as well as the thoracic segments and the pleurites of the abdomen,



but the tergites are more widely separated medially; the sternites also seem to be the same but they are quite impossible to distinguish clearly in this genus due to the heavier pigmentation of the tergites. The chaetotaxy of the last four abdominal segments in the male is more abundant than in the female.

Male genitalia resemble somewhat those of *Formicaphagus* in that the basal plate is short and wide, the parameres are more or less globular, but of quite different shape, and the details of the mesosome differ strongly in the five species represented by males. Unfortunately the five species with male representatives are all from subspecies of *Formicarius analis*. When males have been taken from the other two species, *colma* and *nigricapillus*, they may show important differences, although there are no striking differences between the females of those species and females from the races of *F. analis*.

*Formicaricola analoides*, new species

FIGURES 1,c; 7,d; 9,c

Types: Male and female adults from *Formicarius analis saturatus* Ridgway, collected by the author near Zaragoza, Antioquia, Colombia, Mar. 22, 1948 (USNM).

Diagnosis: This species, the type of the genus, has been quite fully described under the generic characterization. The seven known forms of the genus *Formicaricola* are very similar in general appearance, differing from each other only in many small details, so that one species may resemble several others in shape of head, but have the anterior plate, the cephalic carinae, the thoracic segments or abdominal sclerites quite distinct.

The present species resembles most closely the Costa Rican and Mexican forms from *Formicarius analis umbrosus* and *Formicarius analis moniliger*, but differs as follows: Head smaller than both, wider at tips of marginal carinae and narrower at con; premarginal carinae and nodi differ in shape, as well as postmarginal carinae; pterothorax smaller, with posterior margin straight on the two sides as in *costaricensis* (concave in *mexicana*). Abdominal segment VII in male same shape as in *costaricensis*, but different from *mexicana*, with chaetotaxy of segment VIII different in all three. The anterior margin of segment VIII in the female is convex in *analoides* and concave in *costaricensis* (female of *mexicanus* unknown).

The male genitalia of all three are similar in type but differ in detail, those of *mexicana* resembling more closely those of *analoides*.

The species is represented by the male holotype and female allotype, with other specimens from type host collected at following localities: Regeneración, El Real, and Norosí, Department of Bolívar.

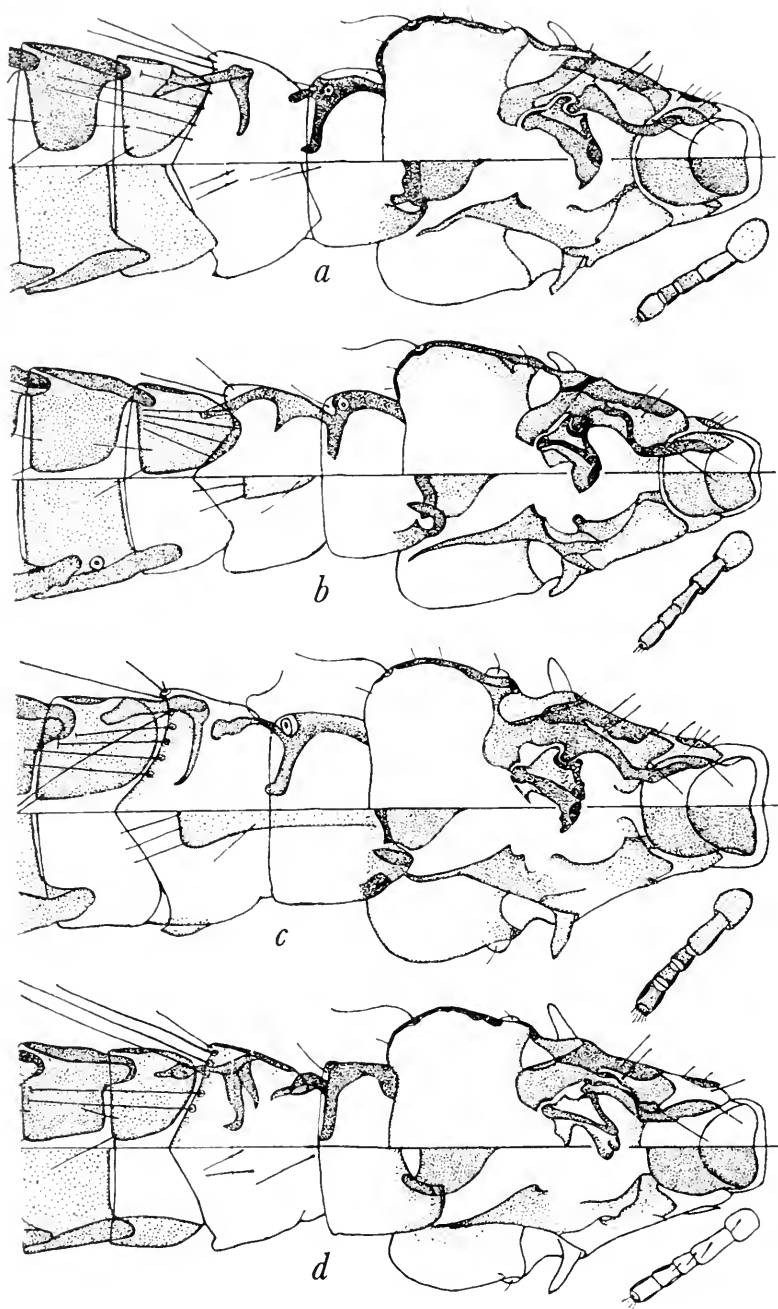


FIGURE 7.—Head, thorax, and certain abdominal segments of male: a, *Formicariicola mexicana* (segments I, II); b, *F. beni* (segments I, II); c, *F. sanctae-martae* (segment I); d, *F. analoides* (segments I, II).

Colombia, 4 females; Heights of Aripo, Trinidad, 1 female, and Sabana Mendoza, Venezuela, 2 females. Another male from *F. a. panamensis*, collected at Unguía, Department of Chocó, Colombia, near the Panamá frontier, cannot be distinguished from the series taken on *F. a. saturatus*.

***Formicuricola costaricensis*, new species**

FIGURES 8,a,g; 9,d

**Types:** Male and female adults from *Formicarius analis umbrosus* Ridgway, collected by the author at Guapiles, Costa Rica, March 1903 (author's collection).

**Diagnosis:** Under the preceding species are given the differences between it and the present form, which need not be repeated. The other species similar to *costaricensis* is *mexicana*, from which it differs in the male sex as follows: Body longer and narrower at abdomen; head slightly longer, but no other difference in measurements; sides of head anterior to conus strongly concave, not straight; tips of pre-marginal carinae anterior to suture, wider and longer; interior carinae, supporting anterior plate, longer and of different shape; eye prominent (obsolete in *mexicana*); conus larger; hyaline margin of frons transverse instead of flatly rounded as in *mexicana*, with front of anterior plate more deeply emarginate; attachment of prothorax to gular plate distinct; sides of prothorax less convex and sides of pterothorax slightly concave instead of convex; posterior margins of pterothorax straight, not concave; anterior margin of abdominal tergite VII sinuate instead of convex, and abdominal chaetotaxy shorter. The genitalia are decidedly different from all of the other known males (fig. 9,d).

The species is represented by the male holotype, female allotype, two female paratypes, and two females from another individual of the type host collected by the author at Guacimo, Costa Rica, April 1903.

***Formicuricola mexicana*, new species**

FIGURES 7,a; 8,i; 9,b

**Type:** Male adult from *Formicarius analis moniliger* Sc Slater, collected by the author at Cerro Tuxtla, State of Veracruz, México, May 5, 1940 (USNM).

**Diagnosis:** This species has been compared in detail with *analoides* and *costaricensis* under the descriptions of those species and needs no further remarks. The figures presented and measurements given are sufficient additional description.

The species is represented by the male holotype and two male paratypes. The female is unknown.

*Formicariicola sanctae-martae*, new species

FIGURES 7,c; 8,f; 9,a

TYPE: Male adult from *Formicarius analis virescens* Todd, collected by the author at Los Gorros, at eastern base of Sierra Nevada de Santa Marta, Colombia, on May 6, 1945 (USNM).

DIAGNOSIS: This species resembles *costaricensis* in shape of anterior half of head, the lateral margins being strongly concave, but differs in having much wider frons, much wider and larger anterior plate, which is wider in anterior portion than in posterior section, a character not found on any of the other species taken on *F. analis* and its races. The eye is very pronounced, as in *costaricensis*, but the carinae connecting the premarginal nodi with the posterior mandibular condyles are distinct, as well as the anterior condyles.

The posterior margins of the pterothorax are strongly concave (straight in *costaricensis*). Abdominal segment VII has the same shape as in *mexicana*, with anterior margin sinuate, but with the lateral angles much less acute; segment VIII is wider in anterior portion than any of the other known males and the margin more circular (fig. 8,f).

The male genitalia resemble those of *costaricensis* in shape of basal plate, but they resemble *mexicana* in the mesosome (fig. 9,a-d).

The species is represented only by the holotype, male.

*Formicariicola beni*, new species

FIGURES 1,d; 7,b; 8,h

TYPE: Male adult from *Formicarius analis analis* (d'Orbigny and La Fresnaye), collected by the author at Santa Ana, Rio Coroico, Bolivia, July 26, 1934 (author's collection).

DIAGNOSIS: The head is decidedly different in shape from all of the other known species, the sides forming a slightly undulating line from temples to the narrow frons; the head also is smaller than in any of the other known males, being especially narrow at the temples ( $0.477 \times 0.35$ , with width at con  $0.28$ ); the anterior plate is also the smallest, almost circular in shape, but slightly longer than wide (fig. 7,b).

The posterior margins of the pterothorax are very different, being deeply emarginate just inside the acetabular bars, then running straight to an acute point. The abdomen is more oval in shape, expanding laterally at segments IV to VI; tergites I to V unusually long, with tergites I to III longer than wide; all pleurite "heads" long, especially ventral portion; segment VIII very narrow, with anterior margin convex, and distinctly divided medially, the only species seen with this character; segment IX differs in shape from that of all the other males (fig. 8,h).

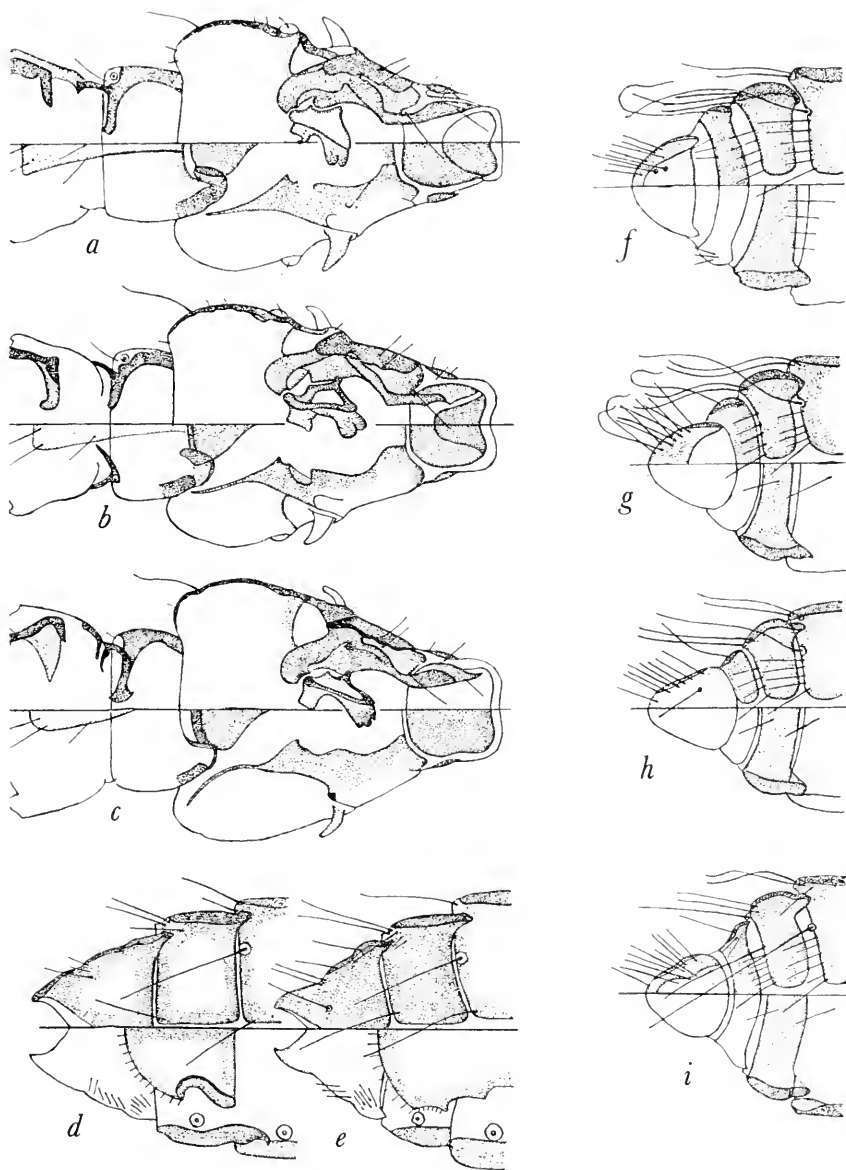


FIGURE 8.—a-c, Head and thorax: a, *Formicaticola costaricensis*, male; b, *F. chocoana*, female; c, *F. colmae*, female. d-i, Tip of abdomen: d, *F. chocoana*, female; e, *F. colmae*, female; f, *F. sanctae-martae*, male; g, *F. costaricensis*, male; h, *F. beni*, male; i, *F. mexicana*, male.

The male genitalia are also unique, being highly complicated, and it is difficult to interpret just what function the different parts perform (fig. 1,*d*).

The species is represented only by the male holotype.

***Formicaricola colmae*, new species**

FIGURE 8,*c,e*

TYPE: Female adult from *Formicarius colma amazonicus* Hellmayr, collected by the author at La Lajita, Río Caura, Venezuela, Nov. 3, 1909 (author's collection).

DIAGNOSIS: This species does not closely resemble any of the other known forms. The head is broad at the temples, with lateral margins convex between temples and preantennal suture; frons wide and transverse, as in *sanctae-martae*; anterior plate large, quadrilateral, with anterior and lateral margins slightly concave

TABLE 2.—Measurements (in millimeters) of the species of *Formicaricola*

Species	Sex	Body length	Head			Prothorax		Pterothorax		Abdomen	
			Length	Width	Width at cunus	Length	Width	Length	Width	Length	Width
<i>analoides</i>	♂	1.58	0.49	0.38	0.293	0.163	0.228	0.195	0.282	0.88	0.287
	♀	2.42	.55	.423	.33	.195	.278	.24	.358	1.38	.46
<i>costaricensis</i>	♂	1.73	.52	.402	.303	.185	.25	.206	.303	.955	.37
	♀	2.06	.542	.44	.345	.18	.265	.24	.337	1.26	.37
<i>mexicana</i>	♂	1.65	.51	.39	.30	.16	.24	.20	.303	.96	.41
<i>sanctae-martae</i>	♂	1.84	.54	.412	.326	.206	.262	.215	.33	1.06	.40
<i>heni</i>	♂	1.65	.477	.35	.280	.16	.228	.185	.25	.97	.358
<i>colmae</i>	♀	1.78	.51	.41	.325	.17	.26	.22	.314	1.04	.435
<i>chocoana</i>	♀	2.13	.52	.38	.305	.17	.24	.228	.285	1.39	.434

and entirely without the darker shield covering anterior portion, being uniformly colored and without markings. Premarginal carinae narrow, with inner margins black; the inner carinae, supporting the anterior plate, are narrow at suture, then expand and cover about half of each side of plate, with their pointed tips reaching almost to edge of frons.

Prothorax and pterothorax with convex sides and both rather wide, the latter with posterior margins concave and median point acute. All tergites except I and II wider than long, with inner margins convex and touching in median portion; pleurites and their "heads" slender, the "heads" not extremely long. Segments VIII and IX are shown in figure 8,*e*.

The male is unknown, the species being represented by the female holotype and three female paratypes.

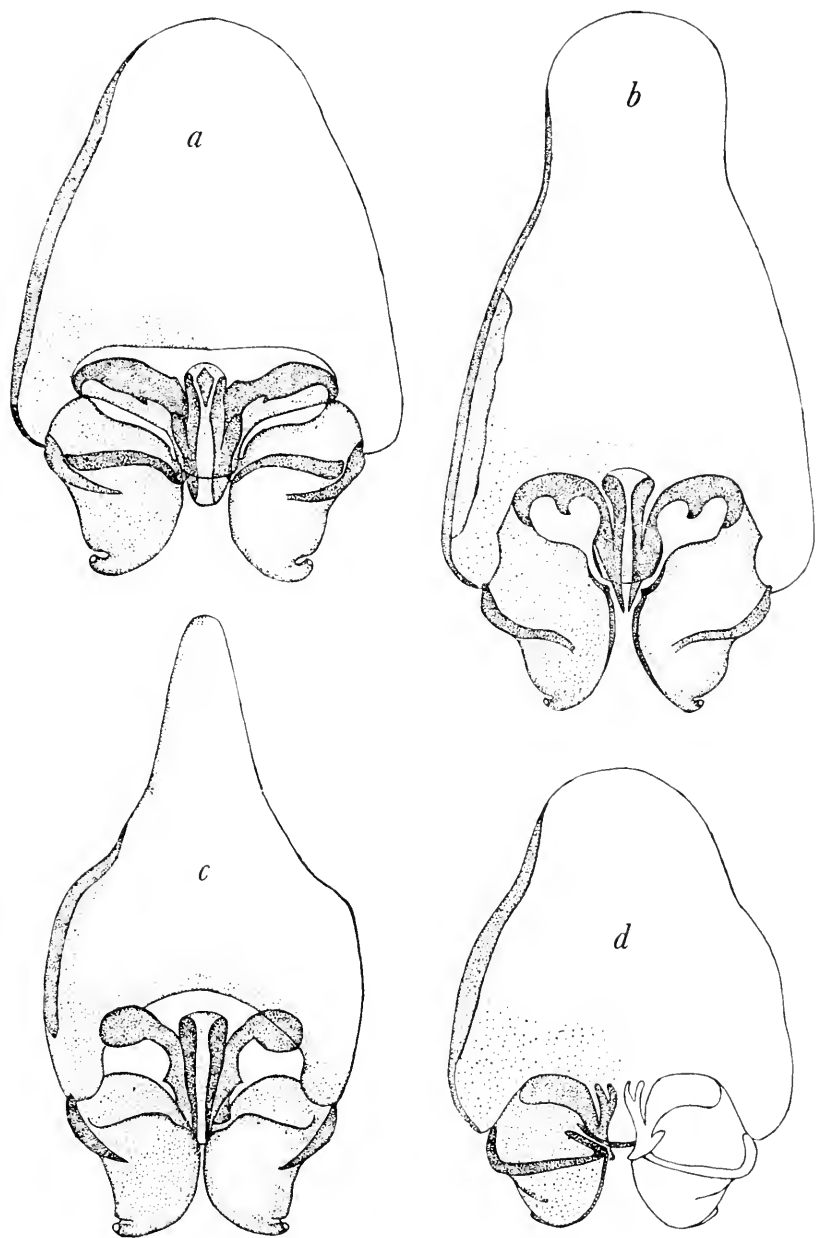


FIGURE 9.—Male genitalia: *a*, *Formicariicola sanctae-martae*; *b*, *F. mexicana*; *c*, *F. analoides*; *d*, *F. costaricensis*.

*Formicaricola chocoana*, new species

FIGURE 8, b, d

TYPE: Female adult from *Formicarius nigricapillus destructus* Hartert, collected by the author at Río Jurubidá, Department of Chocó, Colombia, Mar. 18, 1951 (USNM).

DIAGNOSIS: The largest of the known females of the genus except *analoides* ( $2.13 \times 0.434$  against  $2.42 \times 0.46$ ). Head of average size, with straight, slightly undulating sides and broad, rather deeply

TABLE 3.—List of hosts with their corresponding parasites

Host	Parasite
<i>Cercomacra</i>	
<i>nigricans nigricans</i> Selater	<i>Formicaphagus latifrons</i>
<i>tyrannina tyrannina</i> (Selater)	<i>Formicaphagus latifrons</i>
<i>Formicarius</i>	
<i>analis analis</i> (d'Orbigny and La Fresnaye)	<i>Formicaricola beni</i>
<i>analis moniliger</i> Selater	<i>Formicaricola mexicana</i>
<i>analis saturatus</i> Ridgway	<i>Formicaricola analoides</i>
<i>analis umbrosus</i> Ridgway	<i>Formicaricola costaricensis</i>
<i>analis virescens</i> Todd	<i>Formicaricola sanctae-martae</i>
<i>nigricapillus destructus</i> Hartert	<i>Formicaricola chocoana</i>
<i>colma amazonicus</i> Hellmayr	<i>Formicaricola colmae</i>
<i>Grallaria</i>	
<i>perspicillata intermedia</i> Ridgway	<i>Formicaphagus grallariae</i>
<i>Gymnopathys</i>	
<i>leucaspis bicolor</i> (Lawrence)	<i>Formicaphagus thoracicus</i>
<i>Herpsilochmus</i>	
<i>rufimarginatus frater</i> Selater and Salvin	<i>Formicaphagus minutus</i>
<i>Myrmeciza</i>	
<i>hemimelaena hemimelaena</i> Selater	<i>Formicaphagus angustifrons</i>
<i>immaculata immaculata</i> (La Fresnaye)	<i>Formicaphagus picturatus</i>
<i>laemosticta bolivari</i> de Schauensee	<i>Formicaphagus laemostictus</i>
<i>laemosticta palliata</i> Todd	<i>Formicaphagus magnus</i>
<i>longipes boucardi</i> Berlepsch	<i>Formicaphagus huilae</i>
<i>Myrmotherula</i>	
<i>azillaris fresnayana</i> (d'Orbigny)	<i>Formicaphagus bolivianus</i>
<i>schisticolor interior</i> (Chapman)	<i>Formicaphagus peruvianus</i>
<i>Pernostola</i>	
<i>leucostigma brunneiceps</i> (Zimmer)	<i>Formicaphagus clypeatus</i>
<i>Pittasoma</i>	
<i>michleri zeledoni</i> Ridgway	<i>Formicaphagus splendidus</i>
<i>rufopileatum rosenbergi</i> Hellmayr	<i>Formicaphagus pittasomae</i>
<i>Pyriglena</i>	
<i>leucoptera</i> (Vieillot)	<i>Formicaphagus brevifrons</i>

emarginate hyaline frons; anterior plate slightly wider than long, with anterior edge emarginate, sides convex and posterior margin transverse, and with all four corners rounded; a well-defined shield covers more than half of anterior portion of plate.



The thoracic segments very similiar in shape to those of *costaricensis*, but pterothorax narrower and with posterior margin much like *beni* except that the median point is *rounded*, not *acute*.

The abdomen is the same length as in *analoides*, but narrower; the pleurites are large, black in color both dorsally and ventrally, and with long "heads," much longer ventrally than dorsally. Tergites I to III longer than wide, IV to VI about square, and all are widely separated medially. Segments VIII and IX are shown in figure 8,*d*.

The species is represented by the female holotype, one female paratype, and two females from other individuals of the type host collected by the author near Palestina and Potedó, on the Río San Juan, Department of Chocó, Colombia, on May 5, 1918, and Jan. 3, 1951. The male is unknown.



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A NEW GENUS AND SPECIES OF MARINE ASELOTTE  
ISOPOD. CAECIANIROPSIS PSAMMOPHILA.  
FROM CALIFORNIA

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By ROBERT J. MENZIES<sup>1</sup> and JEAN PETTIT<sup>1</sup>

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Specimens of marine asellote isopods representing a new genus and new species were collected from a coarse-sand beach several centimeters below the surface of the sand, where they were associated with living snails of the genus *Caecum*, the curious pycnogonid *Rhyncothorax*, and several kinds of polychaetes, especially some belonging to the Archiannelida.

Besides the unusual ability of this species to live buried in sand in the intertidal zone, it is of further interest in being the second known American record of a blind intertidal asellote, the first being *Caecijaera horvathi* Menzies (1951, pp. 1-7), a commensal with the wood-boring isopod, *Limnoria*.

The genus resembles *Thambema* (Stebbing, 1913, p. 237), at least superficially, in its elongated aspect and lack of eyes; for that reason it perhaps belongs in the family Thambematidae (Stebbing, 1912, p. 42). Stebbing's report of a single pleotelsonal somite in *Thambema*

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<sup>1</sup> Lamont Geological Observatory of Columbia University, Palisades, N. Y. (This paper is Contribution No. 198 from the Geological Observatory and Contribution No. 1 of the Observatory's Biology Program.)

is probably in error because he shows two somites for the species on plate 36 (Stebbing, 1913). *Caecianiropsis* differs from *Thambema* in having well-developed uropods and in the structure of the male pleopods. The mouthparts are similar. The genus also shows a curious resemblance to the cave-dwelling fresh-water genus *Microcharon* Karaman 1934, one species of which, *Duslenia* (= *Microcharon*, personal communication from Dr. Claude Lévi) *teissieri* Lévi (1950, pp. 42-47), lives also in the intertidal on the coast of France, where it was found in association with an archiannelid polychaete, *Saccocirrus papillocerus* Bobretzky, and the marine mite *Scaptognathus tridens* Trouessart. *Caecianiropsis* differs from *Microcharon* in the structure of the uropods, male pleopods, and the maxillipeds. It seems likely that *Austroniscus ectiformis* Vanhöffen (1914, fig. 80) belongs to *Caecianiropsis*; however, Vanhöffen's specimens seem to be immature and an assignment of that species is uncertain.

### *Caecianiropsis*, new genus

TYPE: *Caecianiropsis psammophila*, new species.

DIAGNOSIS: Maxilliped with two coupling hooks; palp with second and third joints expanded but equaling only  $1\frac{1}{2}$  times the width of endognath. First antenna with peduncle of four joints; flagellum with a few joints. Second antenna about one-half the body length; flagellum multiarticulate.

Epimera visible in dorsal view on peraeon somites 1-7. Endopodite of uropods exceeding twice the length of exopodite.

### *Caecianiropsis psammophila*, new species

#### FIGURES 1-3

HOLOTYPE: Nonovigerous female, length 1.8 mm, width 0.25 mm.

DIAGNOSIS: Rostrum with frontal margin convex. First antennal flagellum with only two articles; first article exceeding six times the length of last. Posterolateral borders of pleotelson of male each with 1-2 minute spinelike teeth; lateral borders smooth except for many small setae; posterior border with a distinct median convexity. Endopod of uropod exceeding three times the length of exopod. Each lateral apex of first male pleopods with a small, expanded, apically pointed area. Anterior endopodite branch of second male pleopod coiled, equaling body length when straightened out.

Character of body: Colorless and eyeless, very much elongated, length exceeding six times the width.

First maxilla: Outer lobe with about 12 denticulate setae at apex; inner lobe with one long seta and numerous fine setae.

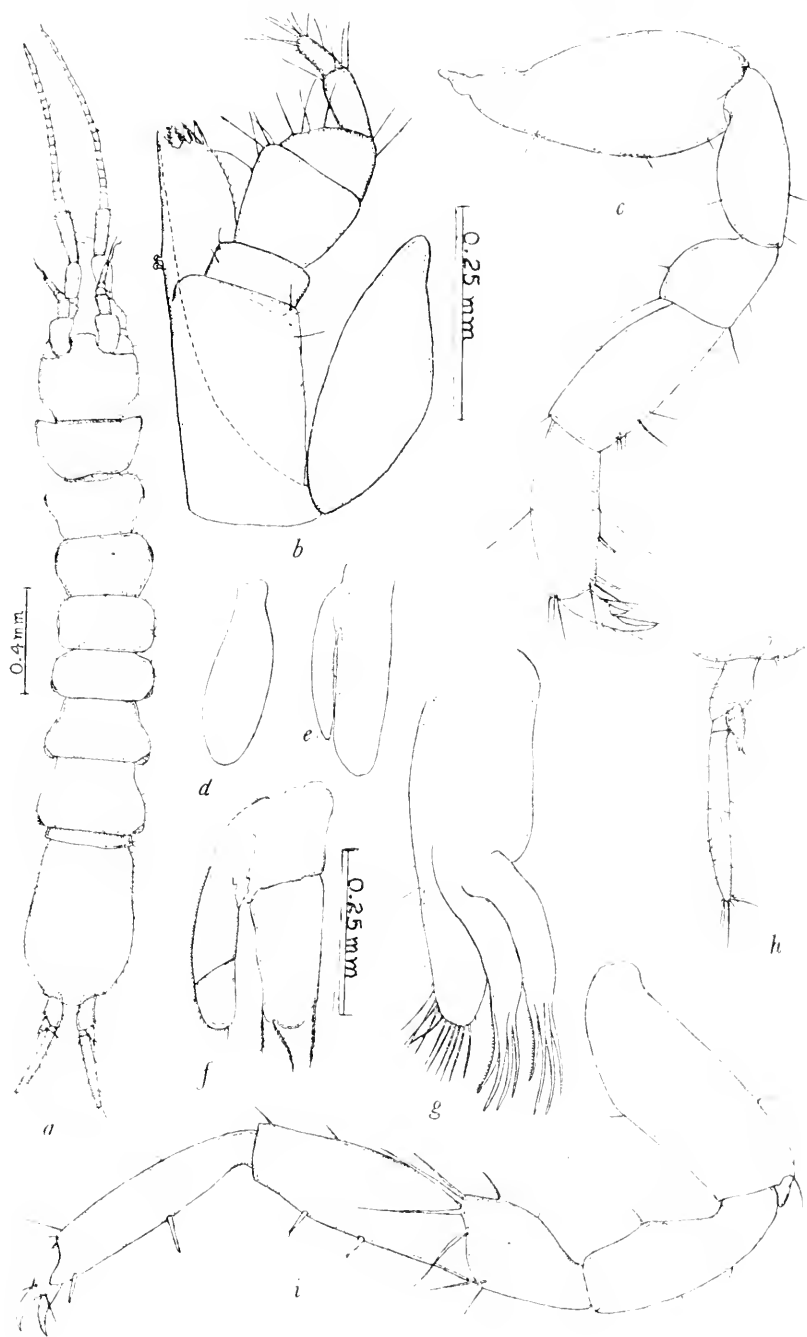


FIGURE 1.—*Caccianiropsis psammophila*, new species: *a*, male paratype; *b*, maxilliped; *c*, first pereopod; *d*, fifth pleopod; *e*, fourth pleopod; *f*, third pleopod; *g*, second maxilla; *h*, uropod; *i*, seventh pereopod. Magnification: *a*, scale at left of figure; *b*, *c*, *i*, scale between figures *b*, *c*; *d*, *e*, *f*, *h*, scale at right of figure *f*; *g*, not known.

Second maxilla: Each of the two outer lobe lappets with four apical setae; inner lobe with about 11 apical setae.

Mandible: Left mandible incisor with five teeth; lacina with five teeth; setal row with five plus one seta. Right mandible incisor with five teeth; lacina lacking; setal row with six setae. Palp with second article depressed at setiferous area which bears three denticulate setae.

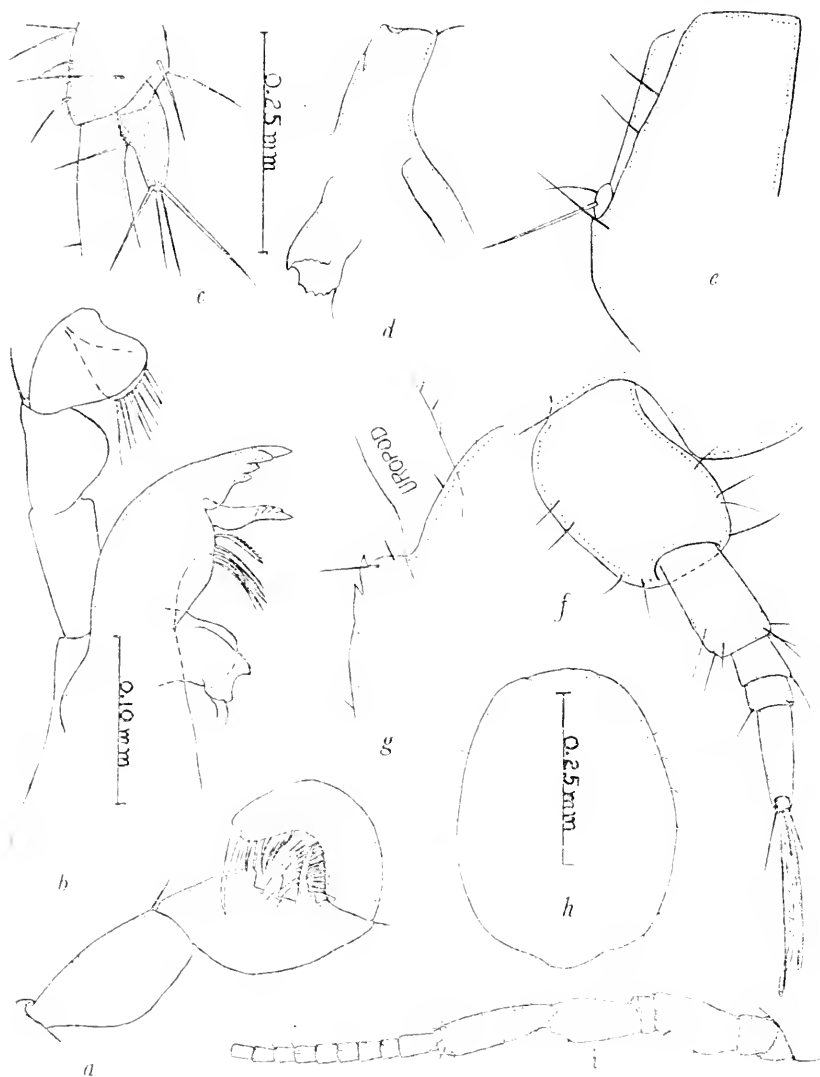


FIGURE 2.—*Caccianropsis psammophila*, new species: a, distal articles of mandibular palp; b, left mandible; c, uropod; d, molar process; e, antennal scale on third article of peduncle of second antenna; f, first antenna; g, posterolateral border pleotelson; h, female operculum; i, second antenna. Magnification: a, as shown on figure d; c, g, f, scale at right of figure c; h, as shown on the figure; i, not known.

TYPE LOCALITY: Tomales Bluff, Tomales Point, reef, Marin County, Calif., in coarse sand about 5 cm. below the surface of sand, mid-intertidal zone, Jan. 27, 1949, R. J. Menzies, holotype; July 9, 1949, 38 paratypes.

MATERIAL EXAMINED: In addition to the above-mentioned specimens the following were examined: Monterey County, Calif.: Asilomar, on tentacle of *Synapta* sp., lower intertidal zone. July 16, 1947, Cadet Hand, 2 paratypes.

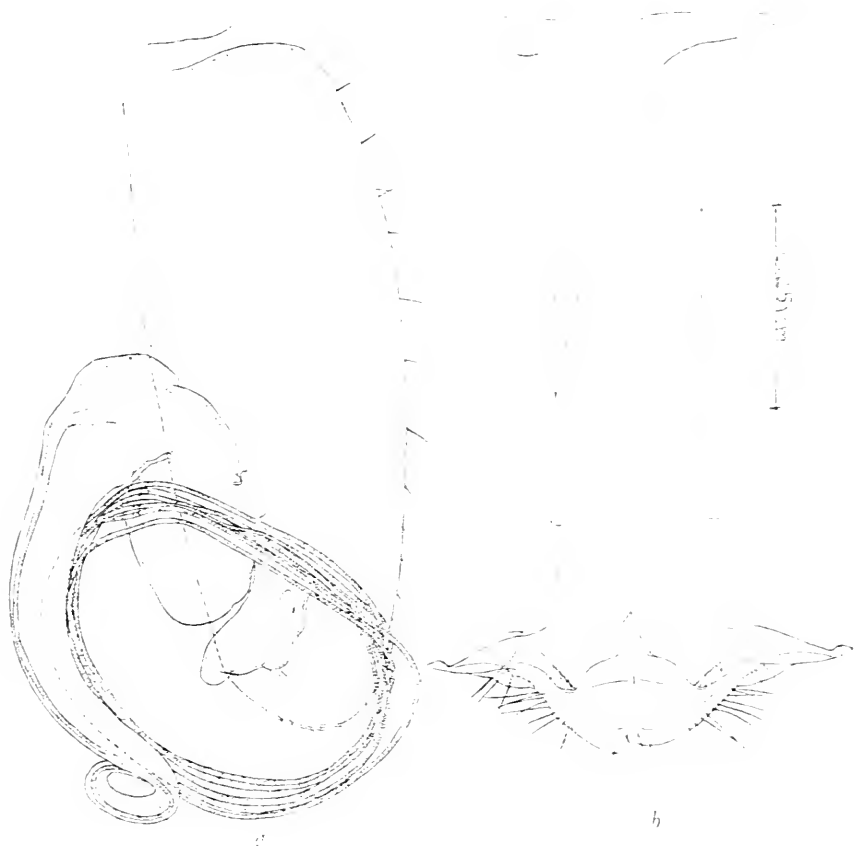


FIGURE 5.—*Caccianiopsis psammophila*, new species: a, second male pleopod; b, first male pleopods, inner surface. Magnification as indicated by the scale.

GEOGRAPHICAL DISTRIBUTION: Marin County to Monterey County, Calif.

TYPES: Type specimens have been deposited in the collections of the following institutions: United States National Museum, holotype, No. 89543, 40 paratypes; Allan Hancock Foundation, 2 paratypes;

Rijksmuseum Van Natuurlijke Historie, Leiden, 2 paratypes; Pacific Marine Station, 3 paratypes, Acc. No. 1330 Arth.

REMARKS: This species differs from *Caecianiropsis ectiformis* (Vanhöffen), its closest known relative, in having spinelike teeth on the posterolateral borders of the pleotelson. Such teeth appear lacking in that species.

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## MAMMALS OF THE ANGLO-EGYPTIAN SUDAN <sup>1</sup>

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By HENRY W. SETZER

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### Introduction

The discovery of factors of medical importance in mammals of the southern Anglo-Egyptian Sudan prompted this study of their taxonomy, distribution, and zoogeography.

The mammalian hosts obtained on a preliminary investigation in 1948 and subsequent studies in 1949-1950 form the basis of the present report. The material was obtained by personnel of U. S. Naval Medical Research Unit Number Three, and it currently bears Chicago Natural History Museum catalog numbers. This collection is to be divided equally between the Chicago Museum and the United States National Museum. Thus, unless otherwise indicated, specimens from localities bearing no museum abbreviation in the "specimens examined" sections of the accounts of species are in the above collection. Specimens from localities such as Bor, Gondokoro, Khartoum, Lake No, and Mongalla, which bear no museum designation, are in the U. S. National Museum from previous African explorations. Locali-

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<sup>1</sup> This paper is based upon studies of the material collected by U. S. Naval Medical Research Unit Number Three. The author is a collaborator with this research group.

ties indicated by italics were either not to be found on any maps available, or would overlap locality dots on the distribution maps. Abbreviations designating other collections examined are: AMNH, American Museum of Natural History; BM, British Museum (Natural History); and MCZ, Museum of Comparative Zoology at Harvard College.

Unless otherwise stated, all measurements are in millimeters and the capitalized color terms are from Ridgway, "Color Standards and Color Nomenclature," 1912. It will be noted that in some accounts total length is used and in others length of head and body. This has been dictated by the type of measurement recorded by the collector on the original label. No effort has been made to translate the total length into length of head and body and tail length, since it is probable that the two measurements would not be comparable.

I would like to express my sincere thanks to the many individuals who have aided in the preparation of this report; especially to the members of the Mammal Room of the British Museum and to Dr. H. W. Parker, its head keeper who so kindly allowed me to incorporate specimen records and to describe new forms in the mammal collection; to Miss Barbara Lawrence of the Museum of Comparative Zoology at Harvard for the privilege of describing new material in that collection; to Colin Campbell Sanborn and the officials of the Chicago Natural History Museum for making their Sudan collection available for study and for the privilege of describing new kinds; to the Office of Research, Medical Department, United States Navy, and to Naval Medical Research Unit Number Three, who made possible the collecting of the material and furnished transportation to England so that I might be able to study the material housed at the British Museum (Natural History); to the director of the United States National Museum and to my associates in the division of mammals who have aided in many ways, to Mrs. Aime Awl, staff artist of the department of zoology who so kindly prepared the maps, and to Mrs. Helen Gaylord who has typed the manuscript through its many drafts.

The Anglo-Egyptian Sudan lies roughly between 3° and 22° north latitude and between 23° and 37° east longitude. Its geographic boundaries encompass approximately 967,500 square miles of territory having quite diverse topography. Almost the entire northern half of the country is extreme desert, while the southern half is predominantly savanna interspersed with isolated mountain masses such as the Jebel Marra, the Nuba Mountains, Mount Baginzi, and the Imatong, Didinga, and Dongotona Mountains in the southeast.

The most conspicuous topographic feature of the Sudan is the Nile River with its tributaries—the Atbara, the Blue Nile, the Sobat, and the White Nile, each with a complex drainage system. In general, the

mammals of the Sudan are not limited in their distribution by the Nile. This is particularly so in the White Nile drainage where vast areas of sudd occur. The formation of sudd dams across channels allows for free interchange of mammal populations from bank to bank in certain areas in the south. The extent to which the Nile serves as a barrier in its more northern reaches is not clearly demonstrable since collections from either bank are not known north of Khartoum. From the scanty evidence available, it does seem that the Nile serves as a barrier to certain kinds of mammals in the more northern reaches but to a less appreciable degree in the south.

Africa has been divided into major biotic districts based on the distribution of plants and birds by Chapin (1932). Some of these districts, in the Sudan, do not seem to correspond to mammal distribution at any taxonomic level. The mammals of the Sudanese Arid District and the Sudanese Savanna District appear to be alike. Only the genus *Galago* seems to have a distribution that fits the general outlines of the Sudanese Savanna District, but this genus occurs also in areas that are referred to the Abyssinian Highland District. The geographic area assigned to the Ubangi-Uelle Savanna District appears to be too large, since no elements of this district have been found east of the Nile. The Abyssinian Highland District does not appear to be represented in the Sudan to any degree. The only element which possibly could be assigned to this district is *Praomys albipes*, whose main range is in the highland area of Ethiopia. The Somali Arid District was thought by Chapin to include the northeastern portion of the Sudan (bounded by Eritrea and the Red Sea) and the portion in the extreme southeast. The former area is probably correctly included in the Somali Arid District since the maned rat *Lophiomys* and the small dik-dik *Rhynchotragus* are found there. No mammals characteristic of the Somali Arid District have been found in the southeastern area, which may be included more properly in the East African Highland District. Otherwise, the bounds assigned by Chapin to the East African Highland District in the Sudan are satisfactory from the point of view of mammalian distribution, since the affinities of most of the mammals of this area are with those of Kenya Colony and East Africa.

In certain areas mammals do not conform as well to the biotic districts of Chapin as do birds. The mammalian fauna of the Sudan is rather homogeneous and the major portion of the country may be assigned to what I would call the Sudanese Arid Savanna District. The remaining parts of the Sudan have mammalian faunas which show some affinity to faunas of the Somali Arid District, the Ubangi-Uelle Savanna District, and the East African Highland District. The area lying along the Ethiopian border is somewhat distinct bo-

tanically but its mammals are poorly known. On the basis of the scant data that is available it seems unlikely that this area can be referred to the Abyssinian Highland District.

Certain areas of endemism are demonstrable. Perhaps the most striking is the Jebel Marra in Darfur Province where a large proportion of the resident mammals have differentiated at least subspecifically. Other places such as Mount Baginzi, the Nuba Mountains, and the Imatong Mountains also show a rather high degree of endemism. The mammalian fauna of the last-named region (with its

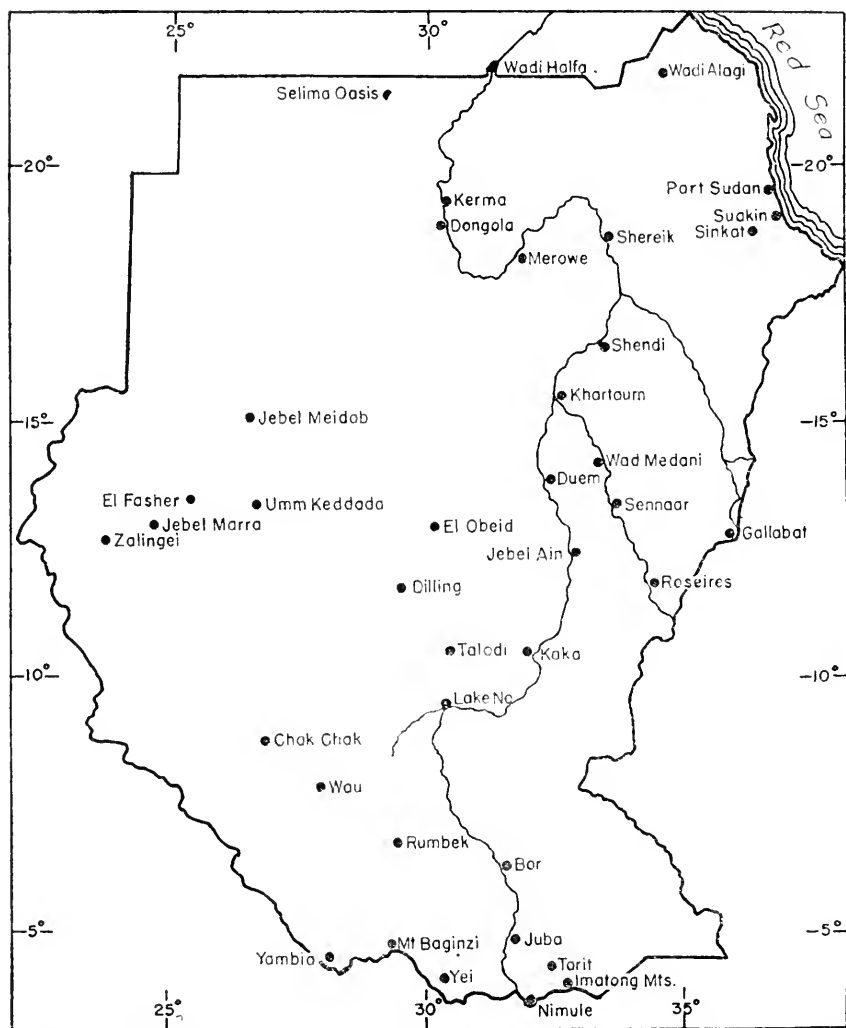


FIGURE 1.—Principal collecting localities in the Anglo-Egyptian Sudan. (Scale: 1 inch = 250 miles.)

companion ranges, the Dongotonas and the Didingas) has a close affinity with the East African fauna but shows a high degree of *in situ* development. These mountain ranges of the southeastern Sudan need much further field work in order to evaluate properly their zoogeographic status and the degree of isolation of their faunas from those of East Africa and from each other. Of the three, only the Imatong Range is adequately represented by specimens. It is interesting that the mammals showing the greatest differentiation are those whose normal habitat is in a forest environment. In these mountains, the forest has become isolated from adjacent forested areas by large regions of arid savanna. This isolation is apparently the result of the dessication of central Africa after the last Pleistocene Pluvial period. Worthington (1937, p. 316) with regard to the great lakes of Africa and their fish faunas, says:

It is yet premature to date the earlier changes involved—the time at which the main rivers of Africa became set in their courses, the formation of the rift valleys, the depression of the Lake Victoria basin, and the reversal of many of the rivers of Uganda. But the later changes, including the dessication of Lake Edward and probably of Lake Victoria can now be dated within reasonably certain limits by correlation with climatic change during the Pleistocene in other parts of Africa and with the glacial and inter-glacial periods in the northern hemisphere. The exact correlation of the individual pluvial and interpluvial periods is not yet fixed, but in general terms the climatic changes which were taking place soon after the beginning of the Pleistocene were responsible both for the glaciations in the north and the pluvials on the equator.

In Europe well-known studies have led to the enumeration or estimation of the number of years since the ice receded from such localities as Stockholm or from certain lakes in Switzerland, and figures of the order of 9,000 to 14,000 years have resulted. If we take the last pluvial of Africa to have finished at about the same time as the last glacial in Europe and apply these figures, we conclude that Lake Rudolf was cut off from its connection with the Nile, say 12,000 years ago, and in that comparatively short time the fish isolated in that lake have changed into the endemic species and subspecies referred to above. Somewhat before this, say between 15,000 and 20,000 years ago, the plateau lakes at the main source of the Nile were dried up, and since they were refilled, adaptive radiation up to the present day has given rise in Lakes Edward and George to eighteen endemic species of Cichlid fish and four of non-Cichlids, and in Lakes Victoria and Kioga, with their more diverse environments and partial isolation from each other, to fifty-eight endemic Cichlids and twenty-seven non-Cichlids. The vast assortment of unique forms in Lake Nyasa and Lake Tanganyika has naturally taken much longer, and to date and understand these we must await the result of future geological and biological studies.

In substantiation of the dating of the end of the Pluvial in central Africa, a corollary may be drawn from the pocket gophers (*Thomomys*) of the Salt Lake Valley and environs in North America. In attempting to determine the time level at which habitat became available for pocket gophers, Durrant (1952, p. 497) says: "The Postpluvial, the last period of Lake Bonneville, has endured from the second

Provo Pluvial until the present. It is thought to be approximately 12,000 years in duration." Thus, in this period of about 12,000 years, differentiation has occurred in the pocket gophers to form the complex distributional pattern of subspecies known today. During a similar interval of time, the mountain forests of central Africa, together with their mammalian faunas, have been isolated by the encroachment of arid savannas. The distinction between the Salt Lake Valley and the isolated mountains of the Sudan is that the former was invaded, then isolated, whereas the latter is a relict of a former widespread habitat now isolated. In both cases, however, differentiation has progressed to the point where pronounced distinctions are evident.

The present report recognizes 91 genera and 224 species and subspecies of mammals other than bats. Of the 224 kinds known from the Sudan, 39.5 percent have been described from localities outside its present geographic boundaries. Of the remaining 60.5 percent, described from within the boundaries of the Sudan, 11 percent have been described from the Imatong Mountains and environs, 8.6 percent from the Jebel Marra and environs, 4.5 percent from the Nuba Mountains area, and the remaining 36.4 percent from many other localities.

It is apparent that the Sudan has been populated by a mammal fauna coming from several directions. The period which apparently has had the most effect on the distribution of present-day mammals is the time immediately after the last Pleistocene Pluvial and up to the present. Most of the mammals occurring in the Sudan today apparently have invaded from the south. Characteristic genera which may be noted in this category are: aard vaark (*Orycteropus*), swamp rats (*Otomys*), tree mice (*Dendromus*), giant rats (*Cricetomys*), multimammate mice (*Mastomys*), mole rats (*Cryptomys*), cane rats (*Thryonomys*), and elephant (*Lorodonta*).

Mammals which apparently have derived from a northern palae-arctic stock and which reach the southernmost limits of their distribution are: gerbils (subgenus *Dipodillus*), sand rats (*Psammomys*), jerboas (*Jaculus*), and the ibex (*Capra*).

Two West African genera which reach an eastern limit of distribution in the Sudan are African striped squirrels (*Tamiscus*) and red-legged ground squirrel (*Euxerus*).

The grass hare (*Poelagus*) appears to be found only in the southern Sudan and extreme northern Uganda. This is apparently the only genus endemic to the region. Another genus (*Desmodilliscus*) is found only in northern Nigeria and the central Sudan; its origin is not determinable at this time.



As may be noted in the following accounts, there are vast gaps in the distributional patterns of practically every species. It is recognized that this report is at best only preliminary and that many of the kinds treated here as species will probably be shown in the future to be related as subspecies. It is hoped, though, that this work will find its way into the hands of interested amateurs and professional zoologists and epidemiologists who will have the opportunity to fill in some of the annoying gaps in the distributional patterns. Much field work remains to be done in the Sudan in order to understand more completely the effects of isolation and the barrier effect of the Nile if such exists.

## Order INSECTIVORA

### Family ERINACEIDAE

#### *Atelerix pruneri lowei*, new subspecies

##### FIGURE 2,a

TYPE: BM No. 23.1.1.35, adult male, skin and skull, from Umm Keddada, Darfur Province, Anglo-Egyptian Sudan. Obtained March 15, 1922, by Lynes and Lowe, original No. 1159.

SPECIMENS EXAMINED: Four, all in BM, from: Umm Keddada, 2; 32 miles east of El Fasher, 1 (skull only); El Obeid, Kordofan Province, 1 (skull only).

DIAGNOSIS: A small extremely pale hedgehog in which the white subterminal band of the spine is broad and the terminal black band is minute. Entire underparts, brow band, hands, and feet white. Skull small, zygomatic arches not widely flaring, interorbital region relatively narrow, postpalatal ridge well developed, mesopterygoid region relatively narrow, upper molars relatively large.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 167; length of tail 16; length of hind foot 25; length of ear 26; condylobasal length of skull 37.4; length of palate 21.4; width of rostrum at level of antorbital foramen 9.6; length of nasals 14.1; least postorbital width 9.9; width across zygomatic arches 23.6.

COMPARISONS: From *Atelerix pruneri pruneri* as known by a specimen from Singa, Blue Nile, *A. p. lowei* differs in markedly lighter color and a smaller skull in all measurements taken.

From *A. p. oweni*, *A. p. lowei* may be distinguished by its markedly lighter color and smaller skull in all measurements taken.

REMARKS: This small hedgehog bears out the pale coloration of most of the other mammals obtained by Lynes and Lowe at lower elevations in Darfur and Kordofan. The extreme amount of white on the spines and the narrowness of the black bands create a strikingly light colored animal.

The type specimen was trapped in a hedgerow of "guffie."

*Atelerix pruneri oweni* (Setzer)

## FIGURE 2,a

*Erinaceus (Atelerix) pruneri oweni* Setzer, Journ. Washington Acad. Sci., vol. 43, No. 7, p. 237. July 23, 1953. (Torit, Anglo-Egyptian Sudan.)

**SPECIMENS EXAMINED:** Nineteen, from: Torit, 9 (2, MCZ); Terangole, 20 miles east of Torit; 4 (1, MCZ); Malek, 1 (BM); Moru District, 2 (BM); Gogrial, 3.

**MEASUREMENTS:** Averages and extremes of four males and two females are as follows: Total length 173 (127–201), 186.5 (152–215); length of tail 12 (10–13), 16 (8–24); length of hind foot 30.5 (28–32); length of ear 24 (16–28), 26.5 (24–29); condylobasal length of skull 41.5 (38.8–45.3), 41.2 (40.2–43.9); length of palate 23.9 (22.3–26.1), 24.2 (23.2–25.2); width of rostrum 11.5 (10.6–11.2), 11.1 (10.6–11.6); length of nasals 13.2 (12.0–14.2), 12.3 (11.5–13.1); least interorbital width 11.0 (10.5–11.5), 11.2 (11.1–11.4); width across zygomatic arches 25.5 (24.2–26.6), 25.8 (25.1–26.7).

**REMARKS:** There is some variation in color of these specimens but this is probably owing to the manner in which the skins have been prepared. If the spines are laid flat in preparation the general tone, as observed from above, is a smoky color; if the spines are semierect the color is darker. Another contributing factor is the amount of pigment on the tip of the spines. If this is slight the general effect is lighter, and, conversely, if there is a relatively wide band at the tip the color appears darker. The only immature specimen in the series is decidedly darker in color than any of the adults. In all specimens except one, the maxillary bone touches the nasal on each side for at least 1.5 mm.

The specimens from Malek and the Moru District are much darker than typical *oweni* or *pruneri*, but the cranial characters seem to refer them to the former.

All the specimens were obtained in savanna-type country between January 7 and April 9.

*Atelerix pruneri pruneri* (Wagner)

## FIGURE 2,a

*Erinaceus pruneri* Wagner, Schreber's Säugethiere, Suppl., vol. 2, p. 23, 1841. (Upper Nile, taken at Sennaar, where Pruner traveled.)

*Erinaceus heterodactylus* Sundevall, Kongl. Svenska Vet.-Akad. Handl., Stockholm (1841), p. 227, 1842. (Bahr-el-Abiad.)

*Erinaceus dimidiatus* Fitzinger, Sitzb. K. Akad. Wiss. Wien, vol. 56, sect. 1, p. 853, 1867. (Sennaar and Kordofan.)

**SPECIMENS EXAMINED:** Five, all in BM, from: Singa, Blue Nile Province, 1; Gebel Auli (near Khartoum), 3; White Nile, near Khartoum, 1.

MEASUREMENTS: No external measurements have been available but the skull of the specimen from Singa, which is unsexed, measures as follows: Condylbasal length 40.9; length of palate 23.6; width of rostrum at level of antorbital foramen 11.4; length of nasals 12.2; least interorbital width 11.8.

REMARKS: The nominate race is darker and, in certain measurements of the skull, smaller than *A. p. oweni*. The outstanding difference in the skulls of these two subspecies is in the width of the postorbital constriction. In *A. p. oweni* the constriction is more pronounced and is uniformly so in all specimens seen.

The specimen from the White Nile, near Khartoum, shows intergrading characters in color and in the size and shape of the upper molar teeth between *A. p. pruneri* and *A. p. lowei*. In substance, these characters are more like those in *A. p. pruneri*, to which the specimen is referred.

***Paraechinus aethiopicus* (Hemprich and Ehrenberg)**

*Erinaceus aethiopicus* Hemprich and Ehrenberg, Symbolae physicae, Mamm., dec. 2, sheet k, footnote, Sept. 1832. (Deserts of Dongola, Anglo-Egyptian Sudan.)

*Erinaceus senaariensis* Hedenborg, Oken's Isis, p. 8, 1839. (Nomen nudum.)

[*Erinaceus*] *brachydactylus* Wagner, Schreber's Säugethiere, Suppl., vol. 2, p. 24, 1841. (Egypt.)

*Hemiechinus pallidus* Fitzinger, Sitzb. K. Akad. Wiss. Wien, vol. 54, sect. 1, p. 565, 1866 (nomen nudum); vol. 56, sect. 1, p. 866, 1867. (Sennaar.)

SPECIMENS EXAMINED: Sixteen, all in BM, from: Port Sudan, 4; Shendi, 4; Khartoum, 4; Sennaar, 2; Sinkat, 2.

MEASUREMENTS: Measurements of an adult male from Sinkat, Red Sea Province, are as follows: Length of head and body 140; length of tail 20; length of hind foot 26; length of ear 30; condylbasal length of skull 43.2; length of palate 22.5; width of rostrum 9.9; length of nasals 13.9; least postorbital width 10.3; greatest width across zygomatic arches 26.2.

REMARKS: This genus might easily be mistaken for *Atelerix* in the field. However, the hairs of the underside of the body are longer and softer and in general show some blotching of brownish or brownish black in the white. On the head the blackish face mask is present in both genera as well as the white band across the forehead. In all specimens of *Paraechinus* examined there was always an indication of a blackish band at the beginning of the spines which is not present in *Atelerix*. In general, the spines of *Paraechinus* are much softer, thinner, and more densely placed than in *Atelerix*. There can be no confusion as to identity when the skulls are examined. In *Paraechinus* the maxillaries do not touch the nasals, and the pterygoid region as well as the auditory region is markedly inflated.

## Family MACROSCOLIDIDAE

*Elephantulus fuscipes* (Thomas)

*Macroscelides fuscipes* Thomas, Ann. Mag. Nat. Hist., ser. 6, vol. 13, p. 68, January 1894. (N'doruma, Niam-Niam country, lat. 5° N., long. 27°30'E.)

SPECIMENS EXAMINED: Two, the type and one other from Obbo.

MEASUREMENTS: The measurements of specimen CNHM No. 67242, an adult female from Obbo, are as follows: Length of hind foot, 29.0; length of ear from notch 23.0; length of nasals 12.2; least interorbital breadth 6.0; greatest width across zygomatic arches 16.7.

REMARKS: These are the sole examples of elephant shrews from this section of the Anglo-Egyptian Sudan. They are readily distinguished from *E. rufescens* by the darker dorsal color, the dark colored feet, and by the plumbeous base of the hairs of the belly.

The type specimen is preserved in alcohol so that any color comparison between specimens is useless. However, the skulls agree in all respects.

*Elephantulus rufescens hoogstraali*, new subspecies

TYPE: CNHM No. 66704, adult male, skin and skull, from Ikoto (lat. 4°5' N., long. 33°4' E.), Equatoria Province, Anglo-Egyptian Sudan. Obtained Dec. 20, 1949, by Harry Hoogstraal, original No. 4995.

SPECIMENS EXAMINED: Forty, from: Ikoto, 31; Torit 9 (1, MCZ).

DIAGNOSIS: Upper parts between Tawny and Russet with a generous admixture of blackish hairs and all hairs with a minute black tip; dorsal color rather abruptly giving way on the sides to Warm Buff strongly intermixed with black; color of side abruptly terminating in the white of the belly; postauricular spots Warm Buff. Underparts, hands, feet, and supra- and subocular spots white; not all of the hairs white to the base, those of the chin, inside of forelegs and hindlegs and a midventral area pure white to base, others plumbeous at base. Tail dark blackish brown above, lighter below. Braincase relatively well inflated, zygomatic arches broad, rostrum relatively short and massive, toothrow relatively short and the bullae well inflated.

MEASUREMENTS OF THE TYPE SPECIMEN: Total length 258; length of tail 130; length of hind foot 36; length of ear from notch 25; greatest length of skull 36.2; length of nasals 13.5; least interorbital width 6.1; greatest width across zygomatic arches 19.6; breadth across external auditory meatus 16.8; width across M<sup>2</sup>-M<sup>2</sup> 11.6; length of upper toothrow entire 17.3; length of auditory bullae 6.3; width of bullae 3.9; condyloincisive length 33.3.

COMPARISONS: From the type specimen of *Elephantulus rufescens dundasi*, this new subspecies differs in: Belly white instead of buffy,

tail generally longer, hind foot longer, more pronounced postauricular spots, and the general dorsal color is darker. The skull has a wider, blunter rostrum, a wider interorbital region, braincase more inflated, zygomatic arches more widely flaring, upper toothrow shorter and the auditory bullae more inflated.

*E. r. hoogstraali* differs from the type and two topotypes of *E. r. delicatus* in: Color darker; the hairs of the belly white and not washed with buff; in both kinds the hairs of the median line are white to the base instead of being plumbeous. The skull is somewhat larger in over-all measurements, bullae are markedly more inflated, wings of mesopterygoid more concave than convex, and the rostrum is generally wider.

From the type of *E. r. marlabanda*, *E. r. hoogstraali* differs in: Color lighter, postauricular spots markedly lighter in color, white hairs of belly white to base in midventral line and not plumbeous. In the skull the rostrum is narrower, nasals narrower, and the zygomatic arches more rounded and less angular.

*E. r. hoogstraali* differs from *E. r. phaeus* in: Lighter dorsal color, hairs of belly white to base and not plumbeous. The skull has the rostrum shorter and wider, zygomatic arches less angular, and the upper toothrow is less crowded.

REMARKS: This series of 40 specimens from the Sudan is remarkably uniform in color and in cranial characters when the sexes are separated and animals of like age are studied. The series was obtained between the middle of November and the end of March. All of the specimens were taken in a savanna habitat of tall grass.

It is apparent when studying the types of the various kinds of *Elephantulus* from eastern Africa that the species referred to as *E. dundasi* is in reality only a subspecies of the earlier *E. rufescens*. There are no characters by which this species can be distinguished, either cranially or from the skin, from specimens of *rufescens* from any part of its range. The characters by which it can be distinguished are no greater than exist between any of the known subspecies. Therefore, although no actual intergradation can be demonstrated, the name should stand as *Elephantulus rufescens dundasi*.

## Family SORICIDAE

### Genus *Crocidura* Wagler

From examining specimens of *Crocidura*, especially the types, in the British Museum and in the U. S. National Museum, I am led to believe that the species groups of Dollman 1915 a-f, 1916 are no more than races of the oldest name in each group. There are, certainly, exceptions to the above statement, such as the case of *Crocidura*

*butleri* which does not fit in the group called *fischeri* on any cranial or morphological feature.

Without examining all of the specimens extant and the references to all the types available, this hypothesis is at best a mere suggestion. Where specimens have been studied and found to agree in what appear to be specific characters they have been placed as a subspecies of that particular species.

Again, this arrangement is based only on the shrews from the Sudan and on specimens immediately adjacent geographically, so that the suppositions and allocations may not be the best, but certainly it shows the relationships of these mammals better than Dollman's revision.

There are three names from the Sudan in this genus that are not, at this time, certainly identifiable. They are *C. ferruginea* Heuglin 1865, from "Lande der Ridj-Neger," *C. fulvastra* Sundevall 1843, from Bahr-el-Abiad, and *C. fusco-murina* Heuglin 1865, from Meshra-el-Req. Dollman, in his revision of the African members of the genus, is not sure of what they are or to what they may be related. For the purpose of this paper these names are considered as unidentifiable.

One specimen, CNHM 73890, is, at this time, not identifiable. It is far darker than anything known from the general region but has a skull which in many ways resembles that of *C. turba*. Since there is only the one specimen I prefer leaving it as indeterminate until more material from the Lokwi region is obtained.

#### *Crocidura bicolor tephragaster*, new subspecies

TYPE: Museum of Comparative Zoology, No. 44773, adult male, skin and skull, from Torit, Anglo-Egyptian Sudan. Obtained Apr. 25, 1950, by J. S. Owen, original number 1158.

SPECIMENS EXAMINED: Eighteen, from Torit (8, MCZ).

DIAGNOSIS: General over-all dorsal color near Mummy Brown, shading over sides to Light Mouse Gray of the belly; hands and feet lighter than the dorsal color; tail dark brownish black well covered with bristle hairs. Skull large for the species, relatively wide across the maxillaries, upper teeth relatively massive, rostrum relatively short and broad.

MEASUREMENTS OF THE TYPE SPECIMEN: Total length 112; length of tail 47; length of hind foot 11; length of ear 4; condyloincisive length of skull 17.4; greatest breadth of braincase 7.2; greatest maxillary breadth 5.2; length of palate 6.1; length of upper toothrow 7.3; least interorbital width 3.5.

COMPARISONS: From the type of *C. b. cunningghamei*, *C. b. tephragaster* differs in: Color lighter, that is, there is more gray and less

brown. The skull has a wider braincase, generally shorter palate, shorter upper tooththrow and a narrower interorbital region.

*C. b. tephragaster* differs from the type of *C. b. woosnami* in the skull being larger in all measurements taken. No color can be compared inasmuch as the body of the type of *woosnami* is preserved in alcohol.

From the type of *C. b. elgonius*, *C. b. tephragaster* differs in: Color about the same but slightly paler in the new form. Hind foot longer; skull larger in all measurements taken.

From the type of *C. b. planiceps*, *C. b. tephragaster* differs in generally lighter color, grayer belly and shorter tail. The skull is shorter, narrower across the braincase, wider interorbitally, and the upper tooththrow is shorter.

REMARKS: This is an example among the white toothed shrews of the Nile apparently acting as a barrier to their distribution. Certainly the specimen of *planiceps* from Rhino Camp is a *bicolor* and differs from the new subspecies from Torit in the manner set forth under comparisons.

#### *Crocidura butleri* Thomas

*Crocidura butleri* Thomas, Ann. Mag. Nat. Hist., ser. 8, vol. 8, p. 375, September 1911. (Between Chak Chak and Deim Zubeir, Bahr-el-Ghazal.)

SPECIMEN EXAMINED: The type.

MEASUREMENTS: The measurements of the type, as given by Thomas (1911, p. 375), are as follows: Length of head and body 78; length of tail 34; length of hind foot 13; condyloincisive length of skull 24.0; least interorbital width 4.5; length of upper tooththrow 10.5.

REMARKS: The type and only specimen available is unique in that the tail is so much shorter and heavier in comparison to other members of the genus. The extremely pale color of this species is approached by shrews of the Sudan, only by *Crocidura pasha* to which it is in no way related.

#### *Crocidura hedenborgiana fuscata* Thomas

FIGURE 2,b

*Crocidura doriae fuscata* Thomas, Ann. Mag. Nat. Hist., ser. 8, vol. 12, p. 90, July 1913. (Kaka, White Nile.)

SPECIMENS EXAMINED: Two, both in BM, from: Kaka, White Nile, 1; Malakal, Upper Nile Province, 1.

MEASUREMENTS: An adult female from Malakal, Upper Nile Province, has the following measurements: Length of head and body 110; length of tail 75; length of hind foot 20; length of ear 11; condyloincisive length of skull 30.7; greatest breadth of skull 12.7; least interorbital width 6.0; length of palate 13.9; greatest maxillary breadth 9.3; length of upper tooththrow 14.0.

REMARKS: Thomas described *fuscosa* as a subspecies of *doriana*, and Dollman, in his revision of the genus, elevated it to specific status and commented that it was quite distinct from *doriana* and that its nearest relative was *hedenborgiana*, from which it was distinguished by its smaller size and somewhat lighter color. I agree with Dollman that *fuscosa* is in no way related to *doriana*, but on critical examination conclude that it is a subspecies of *hedenborgiana*. The proportions of the skulls of the two kinds are identical, which thus leaves only size and color. The size and color differences are not so great that they warrant a separate species for *fuscosa*.

***Crocidura hedenborgiana hedenborgiana* (Sundevall)**

FIGURE 2,b

*Sorex hedenborgiana* Sundevall, Kongl. Svenska Vet.-Akad. Handl., Stockholm, p. 171, 1843. (Sennaar.)

SPECIMEN EXAMINED: Roseires, Blue Nile Province, 1 (BM).

MEASUREMENTS: No external measurements other than for the type are available, but the cranial measurements of the specimen above, an adult female, are as follows: Condylolincisive length 32.9; greatest breadth 13.5; least interorbital width 6.0; length of palate 15.3; greatest maxillary breadth 10.2; length of upper toothrow 15.0.

REMARKS: This very dark shrew, of which one specimen is in the British Museum, is difficult to distinguish from *C. nyansae* cranially, but it is readily separated on the basis of color. In general, this species is larger, more robust cranially than is *nyansae*, with which it appears to coexist.

It may be that if more were known about its natural history and if more specimens were available, it would prove to be a synonym, or at best a subspecies, of *nyansae*. However, owing to the lack of material and information, I feel that it is best to leave the status of the two kinds as they are.

This lone specimen has been compared to Sundevall's type of *hedenborgiana* in Stockholm and agrees very closely with it.

***Crocidura hildegardae phaios*, new subspecies**

FIGURE 2,b

TYPE: MCZ No. 45855, adult female, skin and skull, from Gilo, Imatong Mountains, Equatoria Province, Anglo-Egyptian Sudan. Obtained June 12, 1950, by J. S. Owen, original No. 1266.

SPECIMENS EXAMINED: Four, from: Gilo, 2 (MCZ); Ikoto, 1; Torit, 1.

DIAGNOSIS: General over-all color of upper parts near Bister shading over the sides onto the lighter belly which is gray strongly



washed with Buffy Brown; hands, feet, and tail dark brown. Skull relatively large and robust, upper toothrow short and broad, interorbital region wide, braincase wide, rostrum short and relatively narrow, posterior choanae not constricted, third upper unicuspsids slightly larger than second.

MEASUREMENTS OF THE TYPE SPECIMEN: Total length 116; length of tail 51; length of hind foot 13; length of ear 4; condyloincisive length of the skull 18.7; greatest breadth of the braincase 8.4; greatest maxillary breadth 5.9; length of palate 7.6; length of upper toothrow 7.9; least interorbital width 4.1.

COMPARISONS: *C. h. phaios* differs from *C. h. hildegardae* in generally darker color, wider braincase, and generally wider interorbitum.

From *C. h. altae*, *C. h. phaios* differs in darker dorsal coloration, lighter belly, shorter tail, and smaller skull in all measurements taken.

REMARKS: *C. h. phaios* has been compared only with *hildegardae* and *altae* since they are the closest geographically. The three specimens available are all remarkably alike in both skin and cranial characters, more so than in any of the other *Crocidura* studied from the Sudan.

#### ***Crocidura marita* Thomas and Hinton**

##### FIGURE 2,b

*Crocidura marita* Thomas and Hinton, Proc. Zool. Soc. London, p. 253, July 6, 1923. (Southeast Downs, Jebel Marra, Darfur Province.)

SPECIMEN EXAMINED: The type.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 56; length of tail 38; length of hind foot 10; length of ear 7; condyloincisive length of the skull 16.6; breadth of braincase 7.5; least interorbital breadth 3.4; length of upper toothrow 7.3.

REMARKS: This species is similar in many respects to *C. pasha* but is darker and somewhat larger. It is possible that there exists a close relationship between these two species but until additional material is available it is best to consider them as distinct species.

#### ***Crocidura nyansae darfurea* Thomas and Hinton**

##### FIGURE 2,c

*Crocidura darfurea* Thomas and Hinton, Proc. Zool. Soc. London, p. 251, July 6, 1923. (Zalingei, Darfur.)

SPECIMENS EXAMINED: Eighteen, all in BM, from: Zalingei, Darfur Province, 12; Kulme, Wadi Aribo, 6.

MEASUREMENTS: An adult male and an adult female, from Zalingei, respectively measure as follows: Length of head and body 127, 123;

length of tail 61, 61; length of hind foot 17, 17; length of ear 12, 13; condyloincisive length of the skull 29.1, 28.0; greatest breadth of skull 12.7, 11.7; greatest maxillary breadth 9.2, 9.1; length of palate 12.6, 12.1; length of upper toothrow 12.3, 12.6; least interorbital width 5.2, 5.2.

REMARKS: *Crocidura darfurea* is a lighter colored form of *C. nyansae*. There is no criterion on the skull or skin to warrant the recognition of *C. darfurea* as a full species. It is in all respects another *nyansae*. It is larger and somewhat paler than *C. n. sururae* and larger and decidedly paler than typical *C. nyansae*.

***Crocidura nyansae sururae* Heller**

FIGURE 2,c

*Crocidura sururae* Heller, Smithsonian Misc. Coll., vol. 56, No. 15, p. 2, Dec. 23, 1910. (Rhino Camp, Lado Enclave.)

SPECIMENS EXAMINED: Eleven, from: Bor, 2 (BM); Mongalla, 1 (BM); Malek, 3 (BM); Upper Nile, 1 (BM); Loa, 18 miles north of Nimule, 3 (MCZ); Nimule, 1 (MCZ).

MEASUREMENTS: The measurements of the type, an adult male, are as follows: Length of head and body 111; length of tail 64; length of hind foot 17; condyloincisive length of skull 28.5; breadth of braincase 12.0; length of upper toothrow 13.0.

REMARKS: All of the above specimens are darker than in the original series from Rhino Camp. The skulls, however, show no variation from the type series.

There are no characters of either the skin or the skull in this series which warrant the separation of *sururae* as a full species. There is a specimen from Butiaba, Uganda, which shows rather intermediate characters between *nyansae* and the present form, so it is considered best to refer the above specimens as subspecies of the previously named *nyansae*.

This is a case in which it is possible that Loring collected on the east bank of the Nile. The type locality for *sururae* is at Rhino Camp, which is on the west bank, yet specimens there are found to be identical from Mongalla and Malek.

***Crocidura nyansae toritensis*, new subspecies**

FIGURE 2,c

TYPE: CNHM No. 66713, adult female, skin and skull, from Torit, Equatoria Province, Anglo-Egyptian Sudan. Obtained November 29, 1949, by Harry Hoogstraal, original No. 4862.

SPECIMENS EXAMINED: Twenty-six, from: Torit, 19 (3 MCZ); Gilo, Imatong Mountains, 2; Lotti Forest, Imatong Mountains, 2; Katire, 2 (MCZ); Issore, Imatong Mountains, 1 (BM).

DIAGNOSIS: Hairs of upper parts near Bister, shading over the sides into the somewhat lighter color of the belly; belly silvery gray with a heavy wash of dark buff; hands, feet, and tail all darker brown than the back. Tail clothed with bristle hairs for almost its entire length. Skull large, teeth heavy, upper tooththrow long, braincase wide and relatively flat, posterior choanae relatively wide open, but little constricted, postmandibular processes of skull relatively large, palate wide and long, least interorbital width relatively small.

MEASUREMENTS OF THE TYPE SPECIMEN: Total length 190; length of tail 66; length of hind foot 19; length of ear 8; condyloincisive length of skull 29.5; greatest breadth of braincase 11.6; greatest maxillary breadth 9.3; length of palate 12.6; length of upper tooththrow 13.4; least interorbital width 5.0.

COMPARISONS: *C. n. toritensis* differs from *C. n. sururæ* in darker dorsal coloration and larger general size. The skull differs in that it is larger in all measurements taken with the exception of the least interorbital width which is less; the postmandibular processes are larger in the former than they are in *sururæ* and the palate is wider and longer.

From *C. n. nyansæ*, *C. n. toritensis* differs in somewhat smaller size and lighter color. The skull is smaller in all measurements taken, but the postmandibular processes are of approximately the same size.

REMARKS: The type series of the new kind is quite remarkable for its diversity of color. The series from Torit was taken over most of a 1-year period and this color difference is apparently due to fading and molt. The type appears to be in the new fresh pelage. A peculiar kind of fading occurs in which the reddish brown pigment seems to undergo reduction to a yellowish brown which is quite splotched with newer, more gray pelage coming in. This molt takes place in February and March and there is apparently another molt in October and November.

#### *Crocidura pasha* Dollman

*Crocidura pasha* Dollman, Ann. Mag. Nat. Hist., ser. 8, vol. 17, p. 195, February 1916. (Atbara River, Anglo-Egyptian Sudan.)

SPECIMENS EXAMINED: Five, from: Atbara River, 1 (BM); Khar-toum, 1 (skull, skin in alcohol, BM); Torit, 3.

MEASUREMENTS: Respectively, the external measurements of an adult male and female from Torit are as follows: Total length 87, 91; length of tail 35, 37; length of hind foot 9, 9; length of ear 8, ?. Since the skulls are so badly broken no cranial measurements can be taken.

REMARKS: Even though Torit is quite some distance removed from both the Atbara River and Khartoum, the three specimens from there are identical in color with the type from Atbara. Unfortunately, the skulls of both of the Torit specimens are badly broken, but what is left of them agrees very well with the type of *C. pasha*.

***Crocidura sericea lutrella* Heller**

FIGURE 2,*d*

*Crocidura lutrella* Heller, Smithsonian Misc. Coll., vol. 56, No. 15, p. 4, Dec. 23, 1919. (Rhino Camp, Lado Enclave.)

SPECIMENS EXAMINED: Three, from: Mongalla, 2 (BM); *Rhino Camp*, 1.

MEASUREMENTS: An adult male from Mongalla measures as follows: Length of head and body 75; length of tail 41; length of hind foot 11; length of ear 10; condyloincisive length of skull 20.9; greatest breadth of cranium 8.9; maxillary breadth 6.8; length of palate 8.7; length of upper tooththrow 9.0; least interorbital width 4.2.

REMARKS: *C. lutrella* differs from *C. aridula* in a somewhat more yellowish tone above and a decided buffier gray below. The skulls differ in that *lutrella* is smaller in all measurements taken than is *aridula*. In cranial proportions however, the two kinds agree.

It is apparent that the relationships of *aridula*, *lutrella*, and *marrensis* are with *sericea* and each other; therefore, they are all treated as subspecies of *sericea*, which is the oldest name for the group.

***Crocidura sericea marrensis* Thomas and Hinton**

FIGURE 2,*d*

*Crocidura hindei marrensis* Thomas and Hinton, Proc. Zool. Soc. London, p. 252, July 6, 1923. (Wadi Konger, east-central Jebel Marra.)

SPECIMENS EXAMINED: Two, both in BM, from: *Wadi Burar*, northwestern *Jebel Marra*, 1; Wadi Konger, east-central *Jebel Marra*, 1.

MEASUREMENTS: The measurements of an adult female from the Wadi Burar are as follows: Length of head and body 83; length of tail 58; length of hind foot 13; greatest maxillary breadth of skull 7.0; length of palate 8.7; length of upper tooththrow 9.4; least interorbital width 4.3.

REMARKS: *C. s. marrensis* differs from *C. s. lutrella* in browner color dorsally, darker, longer tail, and much buffier gray underparts. The skulls are practically identical except for the interpterygoid fossa in *marrensis* being more constricted posteriorly. Again, these characters do not appear to be of more than subspecific value.

***Crocidura sericea sericea* (Sundevall)**FIGURE 2,*d*

*Sorex sericeus* Sundevall, Kongl. Svenska Vet.-Akad. Handl., Stockholm, pp. 173, 177, 1843. (Near Bahr-el-Abiad.)

*Crocidura macrodon* Dobson, Ann. Mag. Nat. Hist., ser. 6, vol. 5, p. 226, March 1890. (? Sudan.)

**SPECIMENS EXAMINED:** Ten, all in BM, from: Fashoda (=Kodok), 2; Jebel Ahmed Aga, 1; Lake No, White Nile, 1; *8 miles east of Lake No, White Nile*, 2; Chak Chak, 4.

**MEASUREMENTS:** An adult male and an adult female, from Chak Chak, respectively measure as follows: Length of head and body 96, 98; length of tail 55, 62; length of hind foot 15, 15; length of ear 10, 9; condyloincisive length of skull 24.0, 24.4; greatest breadth of skull 10.6, 10.3; greatest maxillary breadth 7.7, 7.5; length of palate 9.8, 10.5; length of upper toothrow 10.3, 10.6; least interorbital width 5.1, 4.5.

**REMARKS:** *C. s. sericea* differs from *C. s. lutrella* in being larger in all respects, browner on upperparts, and less gray and more buff on the underparts. In *lutrella*, *sericea*, *marrensis*, and *aridula* the flank gland is small and white.

***Crocidura turba nilotica* Heller**FIGURE 3,*a*

*Crocidura nilotica* Heller, Smithsonian Misc. Coll., vol. 56, No. 15, p. 3, Dec. 23, 1910. (Rhino Camp, Lado Enclave.)

**SPECIMENS EXAMINED:** Nine, from: Mongalla, 1 (BM); Malek, 1 (BM); *Rhino Camp*, 7.

**MEASUREMENTS:** The skulls of the two specimens from the Sudan are so badly broken that only the toothrows remain identifiable, consequently, only the external measurements of an adult male from Mongalla and an adult female from Malek are available. Their measurements, respectively, are as follows: Length of head and body 89, 97; length of tail 52, 55; length of hind foot 15, 16; length of ear 11, 10.

**REMARKS:** The two localities from which these specimens come lie on the east bank of the Nile, while Rhino Camp is located on the west bank. It seems odd that so small an animal as this could cross back and forth across the Nile in enough instances to retain the purity of genetic stock. The type specimen of *nilotica* was obtained by J. A. Loring while the Roosevelt party was camped at Rhino Camp. It is always possible that Loring and his companion, E. A. Mearns, may have crossed the river for a few days and trapped for small

mammals there while the rest of the party worked on the west bank. Certainly there is no indication in the field notes or on specimen labels to support this hypothesis, but it seems the only logical one to assume.

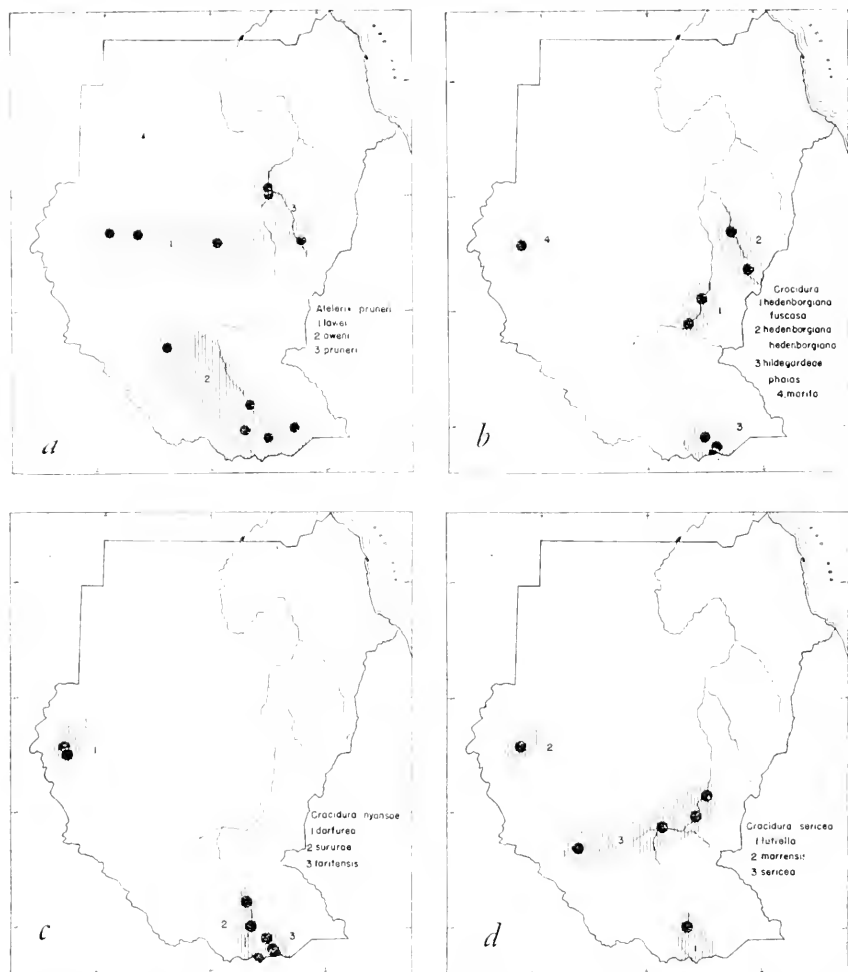


FIGURE 2.—Distribution of *Atelerix* and *Crocidura* (in part) in the Anglo-Egyptian Sudan. (Scale: 1 inch=400 miles.)

### *Crocidura turba tephra*, new subspecies

FIGURE 3,a

TYPE: CNHM No. 79431, adult male, skin and skull, from Torit, Equatoria Province, Anglo-Egyptian Sudan. Obtained March 14, 1952, by J. S. Owen.

SPECIMENS EXAMINED: Eleven, from: Torit, 9 (2, MCZ); Katire, 1 (MCZ); Lokwi, 25 miles south of Torit, 1.

**DIAGNOSIS:** General over-all color of upperparts Hair Brown shading to Mouse Gray on the belly; flank glands same as dorsal color; hands, feet, and tail brownish. Skull relatively long, rostrum relatively long, upper toothrow long and relatively as well as actually wide.

**MEASUREMENTS OF THE TYPE SPECIMEN:** Total length 146; length of tail 52; length of hind foot 15; length of ear 5; condyloincisive length of skull 23.5; greatest breadth of braincase 10.2; greatest maxillary breadth 7.2; length of palate 9.5; length of upper toothrow 10.2; least interorbital width 4.4.

**COMPARISONS:** The only subspecies with which *C. t. tephra* needs to be compared is *C. t. nilotica*, from which it differs in: Color lighter in all respects, size about the same in all respects, skull somewhat longer, braincase wider, width across maxillaries greater, rostrum longer and upper toothrow somewhat longer.

**REMARKS:** This new subspecies is remarkably lighter in color than is *C. t. nilotica*. In none of the specimens examined does the color begin to approach the saturate condition found in the latter. The type series is remarkably constant in color but the size of the skulls varies rather widely. The greatest difference in these skulls is in one old male in which the teeth are worn almost flat. This skull is about 1.5 mm. longer in the condyloincisive length than is that of the type. Most of this extra length is in the posterior development of the braincase, which is more than one millimeter longer than in the type.

## Order PRIMATES

### Family LORISIDAE

#### *Galago senegalensis senegalensis* E. Geoffroy

*Galago senegalensis* E. Geoffroy, Mag. Encycl., vol. 1, p. 38, pl. 1, 1796. (Senegal.)

*Otolicnus teng* Sundevall, Kongl. Svenska Vet.-Akad. Handl., Stockholm (1842), p. 201, 1843. (Bahr-el-Abiad.)

*Galago sennariensis* Gray, Proc. Zool. Soc. London, p. 147, October 1863. (White Nile, Sennaar.)

**SPECIMENS EXAMINED:** Twenty-one, from: Lotti Forest, 1; *Sunnat*, 3; *Imurok*, 4; Magwe, 36 miles southwest of Torit, 2 (MCZ); Khor Gorman, 30 miles west of Rumbek, 1 (BM); Juba, 2 (BM); *Talanga Forest, Imatong Mountains*, 2 (BM); Kulme, Wadi Aribo, 2 (BM); *Goz Abu Gama, White Nile*, 3 (BM); *Rejaf District, Mongalla Province*, 1 (BM).

**MEASUREMENTS:** Averages and extremes of four males from Imurok and of two females from Sunnat, respectively, are as follows: Total length 431 (411-443), 411 (402-420); length of tail 274 (265-284),

260 (252–268); length of hind foot 66 (61–68), 62 (62); length of ear 41 (41), 39 (37–41); greatest length of skull 43.2 (40.7–45.0), 41.3 (39.9–42.7); length of upper canine to  $M^3$  15.2 (15.0–15.5), 14.9 (14.6–15.2); least interorbital width 5.4 (5.1–5.8), 4.75 (4.6–4.8); breadth across orbital ring 29.4 (26.6–31.2), 28.2 (26.6–29.9); length of nasals 10.7 (9.8–11.3), 11.1 (10.3–11.9); breadth of braincase 23.7 (22.9–24.9), 22.2 (21.8–22.6).

REMARKS: All of the specimens examined are somewhat more yellowish and have lighter colored ears than typical *senegalensis*. It is apparent, though, that material from Senegal varies considerably, even within local populations. It is for this reason, and the fact that the present specimens are more widely divergent from other named kinds than from the nominate form, that they are so identified. Perhaps when one has material available from one side of the continent to the other and is able to critically analyze the material, the animals from the Sudan and farther to the east may be shown to be readily separable from the animals from western Africa. Owing to the continuum of habitat across the savannas, the above conjecture may prove to be only wishful thinking.

## Family CERCOPITHECIDAE

### *Papio doguera heuglini* Matschie

*Papio heuglini* Matschie, Sitz. Ges. Naturf. Freunde, Berlin, p. 81, 1898. (Near Shilluk Islands, White Nile, Anglo-Egyptian Sudan.)

*Papio lydekkeri* W. Rothschild, Novitates Zool., vol. 9, p. 140, Apr. 10, 1902. (Upper Blue Nile.)

*Papio werneri* Wettstein, Anz. K. Akad. Wiss. Wien, Math.-Nat., vol. 53, p. 190, 1916. (Gebel Talodi, near Talodi, Nuba Mountains.)

SPECIMENS EXAMINED: Six, from: Ikoto, 1; Torit, 1; *Imurok-Ikoto*, 1; Jebel Marra, 1 (BM); Wau, Jur River, 1 (BM); Kamisa, Dinder River, 1 (BM).

MEASUREMENTS: The skin of an adult female from Kamisa, Dinder River, measures as follows: Length of head and body 597; length of tail 533; length of hind foot 180; length of ear 43. The skull of a young adult male from Imurok measures: Greatest length 235.0; greatest width across zygomatic arches 134.9; least postorbital constriction 60.1; length of canine to  $M^3$  73.8; breadth across  $M^3$ – $M^3$  57.2; condyloincisive length 185.0.

REMARKS: It is strange that so much of the mammal fauna of the Jebel Marra should be so distinct from surrounding areas and that the baboon found there should be the same as that found on the Upper Nile in the southern Sudan. However, the only skin and skull from the Jebel are not distinguishable from the more eastern animals and



are therefore referred to *heuglini* rather than to *P. d. tessellatus* from Ankole, Uganda.

***Cercopithecus aethiops aethiops* (Linnaeus)**

FIGURE 3,*b*

*Simia aethiops* Linnaeus, *Systema naturae*, ed. 10, vol. 1, p. 28, 1758. (Sennaar.)  
*Cercopithecus toldti* Wettstein, *Anz. K. Akad. Wiss. Wien, Math.-Nat.*, vol. 53, p. 189, 1916. (Jebel Riha, near Kadugli.)  
*Cercopithecus (Chlorocebus) cailliaudi* Wettstein, *Denkschr. K. Akad. Wiss. Wien, Math.-Nat.*, vol. 94, p. 643, 1918. (Blue Nile.)

**SPECIMENS EXAMINED:** Fourteen, all in BM, from: White Nile, lat. 14° N., 3; Mongalla, Moru District, 1; Kamisa, Dinder River, 8; Omdurman, 1; near Er Renk, 1.

**MEASUREMENTS:** Average external measurements, respectively, of two males and two females from Kamisa, Dinder River, are as follows: Length of head and body 444.5, 441.3; length of tail 605, 550; length of hind foot 129, 106; length of ear 32, 29.

**REMARKS:** The specimens from Kamisa are virtual topotypes of this subspecies. All of the specimens examined are paler in dorsal coloration than are any of the adjacent kinds. However, there is a considerable amount of variation in the general color. The thighs and lower hind legs are pale gray with only a faint suggestion of the banding which is prominent in *C. a. arenarius*.

***Cercopithecus aethiops arenarius* (Heller)**

FIGURE 3,*b*

*Lasiopyga pygerythra arenarius* Heller, *Smithsonian Misc. Coll.*, vol. 61, No. 17, p. 11, Oct. 21, 1913. (Marelle Waterholes, Marsabit Road, Kenya Colony.)

**SPECIMENS EXAMINED:** Two, both in BM, from Issore, Imatong Mountains.

**MEASUREMENTS:** No measurements of this form are available from the Sudan since the only two specimens are native skins.

**REMARKS:** These two skins are both "native" skins and thus not too reliable but are probably from the Imatong mountains. The thighs and lower hind legs are marked with cross bands of dark gray on a light gray background and not uniformly clear gray as in the next adjacent form *johnstoni*. This marking of the thighs and legs is far more distinct in the Imatong specimens than in topotypes of *arenarius* in the British Museum collection.

I feel that for the present it is best to refer these specimens from the Imatongs to *arenarius* since the material is not adequate to definitely establish their true identity.

*Cercopithecus aethiops marrensis* Thomas and Hinton

FIGURE 3,b

*Cercopithecus tantalus marrensis* Thomas and Hinton, Proc. Zool. Soc. London, p. 248, July 6, 1923. (Foothills of Jebel Marra, Central Darfur.)

SPECIMENS EXAMINED: Three, all in BM, from: Foothills of Jebel Marra, 1; *Southwestern Jebel Marra*, 2.

MEASUREMENTS: The type, an adult male, has the following external measurements: Length of head and body 830; length of tail 1140; length of hind foot 145; length of ear 32.

REMARKS: This subspecies is more reddish in general tone than are its relatives to the east. The thigh and lower leg, instead of being a shade of clear gray, is of a pronounced yellowish tone. Faint grayish bars are present on the upper leg.

In general these animals are larger than any specimens seen of *aethiops* or *arenarius*.

*Cercopithecus mitis stuhlmanni* Matschie

*Cercopithecus stuhlmanni* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 225, 1893. (Kinyawanga, northwest of Lake Albert, Belgian Congo.)

SPECIMENS EXAMINED: Fifteen, from: Lotti Forest, Imatong Mountains 5; Torit, 1; Nagichot, 100 miles east of Torit, 4; *Kipia, Imatong Mountains*, 2 (BM); Emogadung, Dongotona Mountains, 1 (BM); *Char, Didinga Mountains*, 1 (BM); *forests of Mount Lotuke, Didinga Mountains*, 1 (BM).

MEASUREMENTS: An adult male from Kipia, Imatong Mountains, and an adult female from Char, Didinga Mountains, respectively show external measurements as follows: Length of head and body 1168, 1290; length of tail 635, 795; length of hind foot 139, 138; length of ear 38, 36.

*Erythrocebus putas pyrrhonotus* (Hemprich and Ehrenberg)

*Cercopithecus pyrrhonotus* Hemprich and Ehrenberg, Symbolae physicae, Mamm., dec. 1, pl. 10 and folios hh, kk, August 1832. (Darfur.)

*Cercopithecus poliophaeus* Reichenbach, Völlstand. Naturg. Affen, p. 122, 1863. (Fazogli, Blue Nile.)

*Cercopithecus poliophus* Heuglin, Reise in Nordost-Afrika, vol. 2, p. 6, 1877. (Fazogli, Blue Nile.)

*Erythrocebus albigenus* Elliot, Ann. Mag. Nat. Hist., ser. 8, vol. 4, p. 265, September 1909. (Egyptian Sudan.)

SPECIMENS EXAMINED: Six, from: Torit, 3; Kinyeti Valley, Imatong Mountains, 2 (BM); foothills of southern Jebel Marra, 1 (BM).

MEASUREMENTS: The external measurements of an adult male from the foothills of southern Jebel Marra are as follows: Length of

head and body 623; length of tail 725; length of hind foot 162; length of ear 43.

REMARKS: The three specimens from Torit are all juveniles and thus no measurements are reliable or diagnostic of the race. The two specimens from Kinyeti are "native" skins and thus lack measurements. The specimen from Jebel Marra is somewhat lighter in color than are the specimens from the southeastern Sudan and this may represent the typical condition; however, since there are no actual topotypes available, or the type specimen itself, these red monkeys are all referred to *pyrrhonotus*.

*Colobus polykomos dodingae* Matschie

*Colobus* (*Guereza*) *matschiei dodingae* Matschie, Ann. Soc. Malac. Zool. Belgique vol. 57, p. 52, 1913. (Southwestern Dodinga (=Didinga) Mountains, about lat. 4°10' N., long. 33°42' E., 5,650 feet, Kilio.)

SPECIMENS EXAMINED: Fifteen, from: Lotti Forest, 5 (1 BM); *Loronyo*, 1; Imurok, 1; *Imela*, 1; *Issore*, 1 (BM); *Talanga Forest*, *Imatong Mountains*, 1 (BM); forests of Mount Lotuke, Didinga Mountains, 3 (BM); *Kipia*, *Imatong Mountains*, 2 (BM); *Laboni*, *Imatong Mountains*, 1 (BM).

MEASUREMENTS: The external measurements of an adult male and an adult female from Mount Lotuke are, respectively, as follows: Length of head and body 1235, 1276; length of tail 690, 685; length of hind foot 180, 180; length of ear 35, 35.

REMARKS: The specimens from Mount Lotuke may be considered as topotypes of *C. p. dodingae*. The other specimens from the Imatongs and from Torit agree in every detail with those selected as being topotypes.

## Order PHOLIDOTA

### Family MANIDAE

*Manis temminckii* Smuts

*Manis temminckii* Smuts, Dissertation zoologica, enumerationem mammalium Capensium continens, p. 54, pl. 3, figs. 1, 2, 1832. (Cape of Good Hope.)

*Phatages hedenborgii* Fitzinger, Sitzb. K. Akad. Wiss. Wien, Math.-Nat., vol. 65, sect. 1, p. 69, 1872. (Sennaar and elsewhere in northeastern and central Africa.)

SPECIMENS EXAMINED: One, from Torit.

REMARKS: Only this single pangolin is available from the Sudan in any of the collections studied. *Phatages hedenborgii* Fitzinger, from Sennaar and elsewhere in northeastern and central Africa, is an available name for Sudanese pangolins but is listed as a synonym of *temminckii* by Allen (1939, p. 269).

## Order LAGOMORPHA

## Family LEPORIDAE

*Poëlagus marjorita larkeni* St. Leger

FIGURE 3,c

*Poëlagus marjorita larkeni* St. Leger, Ann. Mag. Nat. Hist., ser. 10, vol. 16, p. 598, December, 1935. (Yambio District, 100 miles north of Diawo, southwestern Bahr-el-Ghazal, Anglo-Egyptian Sudan.)

SPECIMENS EXAMINED: Fourteen, all in BM, from: *Sue River, near Diawo*, 2; *Ibba River*, 100 miles north of Diawo, 9; *Mount Baginzi*, 1; *Diawo*, 2.

MEASUREMENTS: There are no external measurements available but cranial measurements of an adult male and an adult female from *Ibba River*, 100 miles north of Diawo, are, respectively, as follows: Greatest length of skull 82.3, 91.0; condyloincisive length 79.8, 89.6; greatest width across zygomatic arches 38.7, 40.2; least interorbital width 18.9, 21.5; breadth of braincase 27.6, 28.7; median length of nasals 29.0, 30.6; greatest width of nasals 17.5, 18.9; length of palatal foramina 20.9, 22.4; greatest width of palatal foramina 8.0, 10.4; width of choanae opposite  $M^3$  6.0, 5.6; length of upper molar series 14.9, 17.0.

REMARKS: Major Larken noted on the original labels that these rabbits were locally very common and easily obtainable. They apparently inhabit the open savanna scrub.

*Poëlagus marjorita oweni*, new subspecies

FIGURE 3,c

TYPE: CNHM No. 73950, adult male, skin and skull, from *Lotti Forest*, southwestern *Imatong Mountains*, *Equatoria Province*, *Anglo-Egyptian Sudan*. Obtained November 21, 1950, by J. S. Owen, original No. 1604.

SPECIMENS EXAMINED: Five, from: *Imela*, 2; *Lotti forest*, 1; *Imurok*, 1 (MCZ); near *Katire*, 1.

DIAGNOSIS: Nuchal spot near Ochraceous-Tawny, gradually shading over the shoulders into the dark dorsal color which is predominantly blackish but speckled with Cinnamon Buff. Hands and feet near Cinnamon Buff on dorsal surfaces, with lips and anterior and posterior parts of belly white and but lightly washed with Cinnamon Buff. Dorsal color extending around throat and middle of belly but not so much black as in dorsal aspect. Underside of tail white, no stripe on dorsal surface. Skull: Braincase broad, rostrum wide, nasals generally narrow, choanae relatively wide, and zygomatic width relatively great.

MEASUREMENTS OF THE TYPE SPECIMEN: Total length 510; length of tail 52; length of hind foot 103; length of ear from crown 85; length of ear from notch 65; greatest length of skull 87.1; condyloincisive length 76.6; greatest width across zygomatic arches 41.2; least inter-orbital width 19.4; breadth of braincase 30.6; median length of nasals 29.6; greatest width of nasals 17.3; length of palatal foramina 21.6; greatest width of palatal foramina 9.2; width of choanae opposite M<sup>3</sup> 6.5; alveolar length of upper molar series 15.8.

COMPARISONS: From *Poëlagus marjorita marjorita*, *P. m. oweni* differs in: Color generally darker, belly with a transverse band of color same as dorsum separating anterior and posterior portions. The skull is different in that the nasals are shorter, braincase narrower, and the auditory bullae are decidedly smaller.

*P. m. oweni* differs from *P. m. larkenii* in darker dorsal color and by the presence of the colored transverse band on the belly. The skull has the braincase broader, the nasals generally narrower, the width of the choanae opposite M<sup>3</sup> greater, and the width across the zygomatic arches greater.

REMARKS: The rabbits taken in the eastern part of Equatoria Province have all come from the Inatong Mountains or the immediate vicinity and all were taken in forest-type habitat. It is very probable that when the Didinga and Dongotona Mountains are better known this animal will be found to inhabit them as well.

*Lepus capensis crawshayi* De Winton

FIGURE 3,d

*Lepus crawshayi* De Winton, Proc. Zool. Soc. London, p. 416, August 1, 1899. (Kitwi, east of Athi River and northeast of Machakos, Kenya Colony.)

SPECIMENS EXAMINED: Six, from: Ikoto, 2; *Katire*, 2; Nagichot, 2 (MCZ).

REMARKS: In a series of 10 adult specimens from the Kapiti Plains, British East Africa, two adult skulls measure 85.8 and 86.6 mm. in occipitonasal length while the other eight adults are 85 mm. or less. Ellerman and Morrison-Scott (1951, p. 427) give 85 mm. or less for occipitonasal length for hares of the *capensis* complex south of the Sahara. It seems then, on the basis of the measurements above, that *crawshayi* belongs to the *capensis* group and not with *europaeus*, where it has been placed by the above authors.

Of the four specimens here referred to *crawshayi*, only one is adult, and in that one the skull is missing. The skin, however, agrees in detail with those specimens in the collection from British East Africa and identified as *crawshayi*.

*Lepus capensis dinderus*, new subspecies

FIGURE 3,d

TYPE: BM No. 14.3.8.45, adult male, skin and skull, from Kamisa, Dinder River, Anglo-Egyptian Sudan. Obtained December 24, 1913, by W. P. Lowe, original No. 47.

SPECIMENS EXAMINED: Twelve, all in BM, from: Jebel Ain, White Nile, 1; Sinkat, 4; Kamisa, Dinder River, 4; White Nile, lat. 13°, 1; Port Sudan, 1; Wad Medina, 1.

DIAGNOSIS: Nuchal spot, bases of ears, forelegs, throat patch, and a thin line on the posterior lateral part of the body, extending onto the hind leg as far as the ankle, near Ochraceous-Buff. This latter line separating the dorsal color from the pure white belly. All white hairs of belly white to the base. Ears darker than any pure color on body but anterior margin of ear with a thin line of Ochraceous-Buff. Dorsum with broadly black-tipped hairs, giving a very dark appearance. Tail white below and with a thin black line on the dorsal surface. Eye completely surrounded by a white ring. Chin, belly, inside of forelegs and hindlegs, pure white. Skull, in dorsal outline, curved; postorbital processes reach frontals above zygomatic arches; nasals relatively short but narrow; upper cheek teeth relatively light; bullae relatively small; choanae nearly parallel sided.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 439; length of tail 79; length of hind foot 105; length of ear 110; greatest length of skull 85.6; condyloincisive length 73.5; greatest width across zygomatic arches 39.5; least interorbital width 17.8; breadth of braincase 28.3; median length of nasals 29.1; greatest width of nasals 18.2; length of palatal foramina 20.6; width of palatal foramina 9.5; width of choanae opposite M<sup>3</sup> 7.4; alveolar length of upper molar series 12.6.

COMPARISONS: *Lepus capensis dinderus* may be distinguished from *Lepus capensis isabellinus* in its generally darker color, somewhat larger size, and the peculiarity of the doming of the cranium as opposed to a relatively flat dorsal outline in the latter.

From *Lepus capensis aegyptius*, *L. c. dinderus* differs in: General ground color of pelage gray instead of brown, somewhat larger size, and the doming of the cranium.

*Lepus capensis dinderus* differs from *L. c. hawkeri* in: Lighter color, broader interorbital region of the skull, smaller auditory bullae, wider basioccipital region, and wider mesopterygoid fossae.

REMARKS: *Lepus capensis dinderus* has a rather wide range north of the central swamps of the Sudan. Its place is taken farther to the south by *Lepus capensis crawshayi*, from which it differs in somewhat

smaller size and brighter color. Of the subspecies of *Lepus capensis* found in the Sudan, *hawkeri* is the most nearly related yet the most distantly removed geographically.

*Lepus capensis hawkeri* Thomas

FIGURE 3,d

*Lepus hawkeri* Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 8, p. 277, October 1911. (Kaka, White Nile.)

**SPECIMENS EXAMINED:** Twenty-one, all in BM, from: Kaka, White Nile, 1; Zalingei, 5; Kulme, Wadi Aribo, 3; 75 miles east of El Fasher, 1; 50 miles east of El Obeid, 1; Gerazi, 1; Dorila Lakes, Jebel Marra, 1; 70 miles west of Nahud, 1; Jaga Jaga, 15 miles east-northeast of El Fasher, 1; Malhab, 1; Agageh Wells, 2; Jebel Ahmed Aga, 3.

**MEASUREMENTS:** An adult male from Zalingei and an adult female from Kulme, Wadi Aribo, measure respectively as follows: Length of head and body 470, 490; length of tail 85, 100; length of hind foot 104, 112; length of ear 103, 112; greatest length of skull 85.9, 90.8; median length of nasals 35.6, 38.7; least interorbital width 17.1, 19.1; greatest width across zygomatic arches 38.2, ?; condyloincisive length 76.3, 79.9; alveolar length of upper molar series 16.2, 16.5; breadth of braincase 33.8, 34.9.

**REMARKS:** This is the darkest subspecies of hare to be found in the Sudan. This darkness is the result of the broad black tips of the hairs of the dorsum. The skull is peculiar in that in dorsal outline it is "domed" and not flattened as in *L. c. isabellinus* and *L. c. aegyptius*. In all other aspects *hawkeri* is quite typical of what is now considered to be the species *capensis*.

*Lepus capensis isabellinus* Cretzschmar

FIGURE 3,d

*Lepus isabellinus* Cretzschmar, in Rüppell, Atlas zu der Reise im nördlichen Afrika von Rüppell, pt. 1, Säugethiere, p. 52, pl. 20, 1826. (Deserts southwest of Ambukol, Sudan.)

**SPECIMENS EXAMINED:** Sixteen, all in BM, from: Shereik, 2; Kerma, 6; Shendy, 8.

**MEASUREMENTS:** No measurements are available for animals from the Sudan, but an adult male and an adult female from Naikhala, Upper Egypt, which agree in detail with specimens from the Sudan, respectively measure as follows: Length of head and body 420, 435; length of tail 92, 90; length of hind foot 103, 105; length of ear 115, 120; greatest length of skull 82.5, 82.5; median length of nasals, 35.2, ?; least interorbital width 17.2, 13.4; greatest width across zygomatic

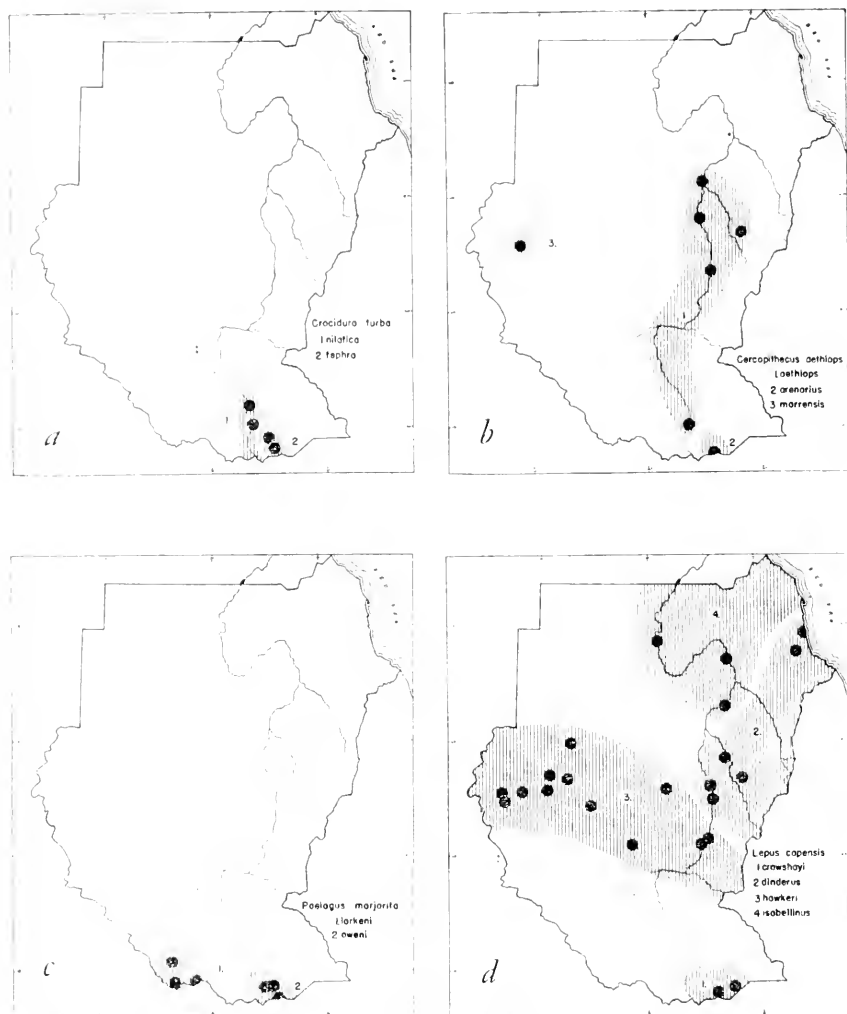


FIGURE 3.—Distribution of *Crocidura* (in part), *Cercopithecus*, *Poelagus*, and *Lepus* (in part) in the Anglo-Egyptian Sudan. (Scale: 1 inch=400 miles.)

arches 39.8, 39.4; condyloincisive length 72.1, 72.8; alveolar length of upper molar series 15.1, 15.6; breadth of braincase 32.6, 33.3.

REMARKS: These animals are the lightest in color of any of the hares found in the Sudan. The skull is characterized by having the post-orbital constriction relatively broad, the palatal bridge narrow, the pterygoid fossa constricted more than is usual, and the upper incisors quite narrow at the cutting edge.



*Lepus victoriae microtis* Heuglin

FIGURE 4,a

*Lepus microtis* Heuglin, Leopoldina, vol. 5, p. 32, June 1865, in Nova Acta Acad. Caes. Leop.-Carol., Halle, p. 24, 1865. ("Lande der Ridj.," Bahr-el-Ghazal.)

**SPECIMENS EXAMINED:** Five, from: Nimule, 1; Torit, 1; *Bor District*, 2 (BM); Gondokoro, 1 (BM).

**MEASUREMENTS:** An adult female from Nimule measures as follows: Total length 507; length of tail 90; length of hind foot 99; length of ear 100; greatest length of skull 88.5; condyloincisive length 75.8; greatest width across zygomatic arches 38.9; least interorbital width 16.9; breadth of braincase 28.0; median length of nasals 30.6; greatest width of nasals 19.5; length of palatal foramina 22.3; width of palatal foramina 8.7; width of choanae opposite  $M^3$  7.2; alveolar length of upper toothrow 16.7.

**REMARKS:** The specimen from Nimule is somewhat darker than the one from Torit, but both specimens are darker than any identified as *victoriae*; both are in color about as in *kakumegae* but cranially are more nearly like *microtis* as identified in the collection.

These specimens are darker than *L. c. crawshayi* and are, in general, larger in all measurements except in length of tail and length of hind foot.

Ellerman and Morrison-Scott refer this subspecies to the species *europaeus*, but from the material available at this time I prefer to use the specific name *victoriae* since there are pelage and cranial differences which appear to separate these animals from the European and Middle Eastern specimens of *europaeus*.

If the few specimens of hares available in the U. S. National Museum are any criterion, then Ellerman and Morrison-Scott are wrong in their assignation of practically all of the hares of Africa to *capensis* and *europaeus* since our material does not conform to the standards of occipitonasal length established to separate the two species.

## Order RODENTIA

## Family SCIURIDAE

## SUBFAMILY Sciurinae

*Tamiscus emini gazellae* Thomas

FIGURE 4,a

*Tamiscus emini gazellae* Thomas, Ann. Mag. Nat. Hist., ser. 9, vol. 1, p. 34, January 1918. (Meridi (= Maridi), Bahr-el-Ghazal.)

**SPECIMENS EXAMINED:** Six, all in BM, from: Maridi, 4; Bahr-el-Ghazal, 1; Aggar Forest, lat. 4°40' N., long. 29°47' E., 1.

**MEASUREMENTS:** The skull of the type specimen, an adult male for which no external measurements are available, measures as follows:

Greatest length 35.2; greatest width across zygomatic arches 19.5; length of nasals 8.9; crown length of upper toothrow 5.7.

REMARKS: It is apparent that this small chipmunk-like squirrel has reached the northern limit of its distribution where the Congo forest extends into the Sudan. These animals appear to be common in the Congo, where they have undergone a great amount of differentiation but appear to be relatively rare in the Sudan.

Unfortunately, all of the skulls in this small series are so badly broken that only on the type could cranial measurements be taken.

*Heliosciurus gambianus bongensis* (Heuglin)

*Sciurus bongensis* Heuglin, Reise in Nordost-Afrika, vol. 2, p. 59, 1877. (Bahr-el-Ghazal.)

SPECIMENS EXAMINED: Six, all in BM, from: *Bahr-el-Ghazal*, 2; Tobbo, 2; Chak Chak, 1; Khor Gitti, 1.

MEASUREMENTS: No external measurements are available for adult animals, but the skull of an adult male from Khor Gitti measures as follows: Greatest length 42.3; condyloincisive length 37.4; greatest width across zygomatic arches 24.9; length of nasals 11.9; crown length of upper toothrow 8.2.

REMARKS: This subspecies is not too uniform in color from the localities examined but it is appreciably darker than *canaster* from the Jebel Marra. The underparts are faintly buffy as opposed to white in *canaster*. The perineal region is bright rufous in *bongensis*.

The skulls of this subspecies may be distinguished from those of *canaster* by the shorter nasals, smaller bullae, and a smaller but more rounded braincase.

*Heliosciurus gambianus canaster* Thomas and Hinton

FIGURE 4,b

*Heliosciurus bongensis canaster* Thomas and Hinton, Proc. Zool. Soc. London, p. 256, July 6, 1923. (Foothills of the Jebel Marra.)

SPECIMENS EXAMINED: Four, all in BM, from the type locality.

MEASUREMENTS: The type, an adult male, and two adult females from the type locality, respectively measure as follows: Length of head and body 178, 173, 171; length of tail 217, 187, 208; length of hind foot 44, 42, 45; length of ear 15.5, 19, 15; greatest length of skull 43.7, 43.7, 43.6; condyloincisive length 38.2, 38.2, 37.9; greatest width across zygomatic arches 25.5, 26.4, 25.4; length of nasals 13.6, 13.7, 13.0; crown length of upper toothrow 8.6, 8.1, 8.4.

REMARKS: Insofar as color is concerned, *H. g. canaster* and *H. g. lateris* approach one another quite closely. In the former, though, the color is just a bit less intense and the rufescent perineal region, absent entirely in the latter, is present to a slight degree.

In one of the specimens pelage change is occurring on the tail and the new hairs are coming in a strikingly banded black, white, and gray pattern while the old hairs have faded to a rather uniform brown.

*Heliosciurus gambianus hoogstraali* Setzer

FIGURE 4,b

*Heliosciurus gambianus hoogstraali* Setzer, Proc. Biol. Soc. Washington, vol. 67, p. 87, Mar. 22, 1954. (Ikoto, Torit District.)

SPECIMENS EXAMINED: Sixteen, from: Ikoto, 9; Torit, 6; Obbo, 1.

MEASUREMENTS: Averages and extremes for six males and three females from Ikoto are, respectively, as follows: Total length 430.1 (410–445), 423 (417–426); length of tail 227.7 (213–242), 207 (204–209); length of hind foot 51.6 (51–53), 51.6 (51–52); length of ear 16.6 (15–17.5), 17 (16–18); greatest length of skull 48.4 (46.5–49.9), 49.2 (48.6–49.7); condyloincisive length 43.0 (40.7–44.9), 43.9 (43.5–44.6); greatest width across zygomatic arches 28.4 (26.6–29.2), 28.7 (28.6–29.0); length of nasals 14.9 (14.2–15.6), 15.1 (15.0–15.2); crown length of upper tooththrow 9.2 (8.8–9.5), 9.1 (8.8–9.3).

REMARKS: This is the largest and darkest of the subspecies of *H. gambianus* found in the Sudan. Intergradation with *H. g. omensis* and *H. g. lateris* is apparent in the single specimen available from Obbo and in three of the six specimens from Torit.

*Heliosciurus gambianus lateris* Thomas

FIGURE 4,b

*Heliosciurus multicolor lateris* Thomas, Ann. Mag. Nat. Hist., ser. 8, vol. 4, p. 102, August 1909. (Lado.)

SPECIMENS EXAMINED: Two, the type and a specimen from Kajo Kaji, 60 miles south of Rejaf, both in BM.

MEASUREMENTS: The type, an adult female, has no external measurements on the tag, but the skull measures as follows: Greatest length 45.5; condyloincisive length 40.4; greatest width across zygomatic arches 26.7; length of nasals 15.4; crown length of upper tooththrow 8.5.

REMARKS: This squirrel is intermediate in color between *bongensis* farther to the west and *madogae* to the east. In this respect only is it intermediate, since in cranial characters there is no evidence of there being any intergradation.

This complex of *gambianus* squirrels occurring in the southern Sudan is rather inexplicable. It seems without reason that three subspecies could occupy so small a geographic area as is apparent. Yet, when specimens are examined, there are morphological characters of the cranium as well as color differences of the skin to warrant the separation of these kinds.

*Heliosciurus gambianus madogae* Heller

FIGURE 4,b

*Heliosciurus multicolor madogae* Heller, Smithsonian Misc. Coll., vol. 56, No. 17, p. 1, Feb. 28, 1911. (Uma, 50 miles north of Nimule.)

SPECIMEN EXAMINED: The type.

MEASUREMENTS: The measurements of the type specimen are as follows: Length of head and body 202; length of tail 204; length of hind foot 44; condyloincisive length of skull 41.5; greatest width across zygomatic arches 27.5; length of nasals 14.0; crown length of upper toothrow 9.0.

REMARKS: Intergradation between this form and *hoogstraali* has been shown in specimens from Torit. Even though the type localities of these two forms are rather close together, there are color and cranial differences which separate them readily. In color, they may be separated by the belly which is white in *hoogstraali* and buffy in *madogae*. The skulls may be distinguished by the following: in *hoogstraali* the skull is larger, has larger auditory bullae, has the braincase less rounded, and with the upper toothrows parallel and not diverging posteriorly.

It would be interesting to have more examples of these squirrels from this area for a more critical analysis of their characters. It may well be that, when more material is available, especially from the type locality of *madogae*, the name *hoogstraali* will have to fall as a synonym; however, for the present and based on available material, the two kinds are readily separable.

*Euxerus erythropus chadensis* Thomas

FIGURE 4,c

*Euxerus erythropus chadensis* Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 15, p. 387, April 1905. (Yo, Lake Chad.)

SPECIMENS EXAMINED: Three, all in BM, from: Jebel Meidob, 1; El Fasher, 1; 35 miles west of El Fasher, 1.

MEASUREMENTS: An adult female from Jebel Meidob measures as follows: Length of head and body 248; length of tail 207; length of hind foot 58; length of ear 15; greatest length of skull 57.2; condyloincisive length 52.0; greatest width across zygomatic arches 31.0; length of nasals 17.5; crown length of upper toothrow 11.5.

REMARKS: These animals are far paler in color than any of the surrounding races of this species, and, apparently, the name *chadensis* is to be recognized as occurring in the Sudan. The specimens agree in detail with animals from Yo, Lake Chad, in color and in cranial features.

*Euxerus erythropus leucoumbrinus* (Rüppell)

FIGURE 4,c

*Sciurus leucoumbrinus* Rüppell, Neue Wirbelthiere zu der Fauna von Abyssinien gehörig . . . , Säugethiere, p. 38, 1835. (Abyssinia, Sennaar, and Kordofan; restricted to Abyssinia by Thomas.)

**SPECIMENS EXAMINED:** Twenty-seven, from: Torit, 9; Obbo, 1; Katire, 1; Opari, 50 miles southwest of Torit, 1; Soba, Blue Nile, 1 (BM); Roseires, Blue Nile, 5 (BM); *Wadferua*, Blue Nile, 2 (BM); Malek, 1 (BM); Kamisa, Dinder River, 3 (BM); near Gedaref, 1 (BM); *no locality except Sudan*, 2 (BM).

**MEASUREMENTS:** Averages and extremes of two males and three females, from Torit, are: Total length 444 (425–463), 454 (448–461); length of tail 205 (203–208), 202 (197–207); length of hind foot 67 (66–68), 65 (64–66); length of ear 15.75 (15.5–16), 16.3 (16–17); greatest length of skull 58.0 (56.2–59.8), 60.1 (58.4–61.8); condyloincisive length 52.5 (50.7–54.4), 54.0 (51.5–56.6); greatest width across zygomatic arches 29.6 (29.6), 31.7 (30.9–33.3); length of nasals 16.8 (15.8–18.4), 18.4 (17.2–19.5); length of upper toothrow except P<sup>3</sup> 10.1 (9.5–11.8), 11.4 (10.6–11.8).

**REMARKS:** In general, *E. e. microdon* from British East Africa has a longer narrower rostrum and a more vaulted cranium than does *E. e. leucoumbrinus*. In the present series from Equatoria Province there are skulls which are close approximations to the former in nasals but to the latter in the degree of vaulting; and the converse is seen as well as the intermediate type. However, I feel that the squirrels from this Province are intergrades between *microdon* and *leucoumbrinus* but, owing to the more constant approach in coloration, that they are more referable to the latter.

One specimen from Soba approaches the paleness of *limitaneus* but cranially is identical to *leucoumbrinus*, and it is thus so referred. This paleness of color may be due to seasonal fading of the pelage and not to some genetic factor.

*Euxerus erythropus limitaneus* Thomas and Hinton

FIGURE 4,c

*Euxerus erythropus limitaneus* Thomas and Hinton, Proc. Zool. Soc. London, p. 255, July 6, 1923. (Zalingei, Darfur.)

**SPECIMENS EXAMINED:** Eleven, all in BM. from: Kulme, Wadi Aribo, 3; Jebel Marra, 2; Zalingei, 1; Dilling, 2; Chak Chak, 2; Talodi, 1.

**MEASUREMENTS:** The type, an adult female from Zalingei, and an adult male from Jebel Marra respectively measure as follows: Length

of head and body 270, 316; length of tail 246, 247; length of hind foot 65, 68; length of ear 17, 16; greatest length of skull 62.5, 62.9; condyloincisive length 57.5, 57.6; greatest width across zygomatic arches 33.4, 32.7; length of nasals 19.3, 19.8; crown length of upper tooththrow except  $P^3$  11.9, 11.9.

REMARKS: The color difference between *limitaneus* and *leucoumbrinus* is quite pronounced. The former is quite pale and rather uniform in color in the series examined, while the latter is relatively dark and not so uniform in the intensity of color. The only specimens showing a deviation in color are those from Dilling and Talodi. The specimens from these two localities are darker than the Jebel Marra material but are lighter than specimens from east of the Nile. In cranial characters they are like *limitaneus*.

## Family CRICETIDAE

### Subfamily Lophiomyinae

#### *Lophiomyys imhausi aethiopicus* (Peters)

FIGURE 4,*d*

*Phractomys aethiopicus* Peters, Zeitschr. Ges. Naturw., Berlin, vol. 29, p. 195, 1867. (Maman, north of Kassala, Anglo-Egyptian Sudan.)

SPECIMEN EXAMINED: One, from near Port Sudan, in BM.

MEASUREMENTS: The above specimen, an adult male, measures as follows: Length of hind foot 42; length of ear 20; greatest length of skull 55.2; condyloincisive length 50.2; length of anterior palatine foramina 8.5; crown length of upper tooththrow 11.7; greatest width across zygomatic arches 30.8; length of nasals 17.9; least interorbital width 11.1; greatest breadth of cranial shield 31.9; width of rostrum at level of antorbital foramen 8.5.

REMARKS: The subspecific name as used above is only tentative since there appears to be some doubt as to its validity. Certainly the only specimen available was different in color and in general size from typical *imhausi* identified as such in the British Museum. No specimens of typical *aethiopicus* were available for comparison.

### Subfamily Gerbillinae

#### Genus *Gerbillus* Desmarest

Ellerman (1941, pp. 502-503) attempted to group the various species of the subgenus *Dipodillus*. He placed *lowei* in the *campestris* group; *principulus* in the *garamantis* group; *stigmatonyx*, *watersi*, and *mackilligini* in the *dasyurus* group; and *muriculus* in the *simoni* group.

I cannot comment on the species extralimital to the Sudan, but certainly the species found in the Sudan fall into three rather well defined morphological groups. Species in the first group are larger, the bullae are not greatly inflated, the cheekteeth are relatively massive, and the pterygoid fossae are fully open. To this group belong *stigmonyx* and *lowei*. Species in the second group are small bodied, the bullae are enormously inflated, the cheekteeth are small, and the pterygoid fossae are relatively closed owing to the encroachment of the anterior ends of the auditory bullae. To this group belong *watersi*, *principulus*, *muriculus*, and *mackilligini*.

In no way can I see that *stigmonyx* and *watersi* are related, but it is quite evident that *principulus* and *watersi* are closely allied and the former may even be only a subspecies of the latter.

The third group of the subgenus would contain the species *bottai*, which agrees with neither of the above groups but has minute auditory bullae and quite open pterygoid fossae. The cheekteeth are even more massive in proportion to the size of the skull than in the group characterized by *lowei* and *stigmonyx*.

Since it is apparent that the groups as proposed by Ellerman are untenable for animals of the Sudan, I would propose that the first complex be known as the *stigmonyx* group; the second as the *watersi* group; and the third as the *bottai* group with the characters as given above.

***Gerbillus (Dipodillus) bottai* Lataste**

FIGURE 4,*d*

*Gerbillus bottai* Lataste, Le Naturaliste, vol. 4, No. 5, p. 36, Mar. 1, 1882. (Sennaar.)

**SPECIMENS EXAMINED:** Two from Sennaar, both in BM.

**MEASUREMENTS:** An adult female from Sennaar has no external measurements, but the skull measures as follows: Greatest length 22.7; condyloincisive length 19.6; length of anterior palatine foramina 3.8; crown length of upper toothrow 3.5; length of auditory bullae 7.4; least interorbital width 4.2; length of nasals 7.8; width of rostrum at level of antorbital foramen 2.8.

**REMARKS:** This is a relatively dark, short-tailed species, resembling in color *G. mackilligini* but somewhat more pallid. The auditory bullae are extremely minute for a member of the genus, smaller even than in *G. muriculus*. The skull may be distinguished from all of the other species by the small bullae and the extremely wide-open pterygoid fossae. The upper cheekteeth are relatively heavy for such a small skull.

*Cerbillus (Dipodillus) lowei* (Thomas and Hinton)FIGURE 4,*d*

*Dipodillus lowei* Thomas and Hinton, Proc. Zool. Soc. London, p. 261, July 6, 1923. (Jebel Marra, Darfur.)

SPECIMENS EXAMINED: Twenty-four, all in BM, from: Jebel Marra, 12; Southeast Downs, Jebel Marra, 2; *central Jebel Marra*, 10.

MEASUREMENTS: The averages and extremes of two males and three females, from Jebel Marra, are, respectively, as follows: Length of head and body 111 (109–113), 110 (110); length of tail 146 (141–151), 146 (143–152); length of hind foot 25.5 (24–27), 26 (25–28); length of ear 15.5 (15–16), 16 (15–17); greatest length of skull 30.9 (30.5–31.3), 30.7 (29.2–31.7); condyloincisive length 26.9 (26.7–27.2), 26.8 (25.1–28.1); length of anterior palatine foramina 6.0 (5.8–6.3), 5.8 (5.3–6.2); crown length of upper toothrow 4.35 (4.3–4.4), 4.4 (4.3–4.6); length of auditory bullae 9.3 (9.2–9.4), 9.4 (8.8–9.7); least interorbital width 5.3 (5.2–5.4), 5.3 (5.1–5.5); length of nasals 11.7 (11.6–11.9), 11.9 (11.6–12.3); width of rostrum at level of antorbital foramen 3.2 (3.1–3.3), 3.0 (2.9–3.1); greatest width across zygomatic arches 15.6 (15.6), 15.2 (14.9–15.6); greatest breadth of braincase 14.7 (14.7), 14.2 (14.1–14.3).

REMARKS: This species is large and dark, by far the most saturate of any of the gerbils found in the Sudan. The white has been reduced to a minimum on the hands, feet, belly, and cheeks. The tail is dark with a black brush but which is not so well developed as in *G. mackilligini*. The skull is more massive than in *G. stigmomyx* and is quite reminiscent of the skull of the smaller members of the genus *Tatera*.

*Cerbillus (Dipodillus) mackilligini* (Thomas)FIGURE 4,*d*

*Dipodillus mackilligini* Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 14, p. 158, August 1904. (Wadi Alagi, eastern desert of Nubia, about lat. 22° N., long. 35° E.)

SPECIMENS EXAMINED: Four, all in BM, from Eastern Egyptian desert, lat. 22° N., long. 35° E.

MEASUREMENTS: An adult male and an adult female, from the above locality, respectively measure as follows: Length of head and body 78, 75; length of tail 138, 114; length of hind foot 24, 22; length of ear 14, 12; greatest length of skull 27.0, 26.2; condyloincisive length 23.4, 22.7; length of anterior palatine foramina 4.7, 4.6; crown length of upper toothrow 3.7, 3.8; length of auditory bullae 10.1, 9.5; least interorbital width 4.8, 4.8; length of nasals 10.6, 9.8; width of rostrum at level of antorbital foramen 2.7, 2.6; greatest width across zygomatic arches 13.5, 13.2; greatest breadth of braincase 13.5, 13.4.



REMARKS: When compared to *Gerbillus watersi*, *G. mackilligini* is larger and much darker in color and with the tail brush well developed. The extent of the white areas has been markedly reduced. The skull is larger, the molars are markedly larger, and the pterygoid fossae are relatively closed as opposed to quite open in the latter. The auditory bullae are relatively, as well as actually, longer and more inflated. The infraorbital foramina are smaller.

***Gerbillus (Dipodillus) muriculus* (Thomas and Hinton)**

FIGURE 4,d

*Dipodillus muriculus* Thomas and Hinton, Proc. Zool. Soc. London, p. 263, July 6, 1923. (Madu, 80 miles northeast of El Fasher.)

SPECIMENS EXAMINED: Two, both in BM, from: Madu, 80 miles northeast of El Fasher, 1; 90 miles northeast of El Fasher, 1.

MEASUREMENTS: The type, an adult male, measures as follows: Length of head and body 65; length of tail 82; length of hind foot 18; length of ear 12; greatest length of skull 23.0; condyloincisive length 19.7; length of anterior palatine foramina 3.6; crown length of upper tooththrow 3.2; length of auditory bullae 7.8; least interorbital width 4.2; length of nasals 8.9; width of rostrum at level of antorbital foramen 2.3; greatest width across zygomatic arches 11.8.

REMARKS: *Gerbillus muriculus*, when compared to *G. principulus*, is smaller and more reddish in color. The dorsal color is carried onto the dorsal surface of the tail in the former and not in the latter. The skull is markedly smaller but the anterior palatine foramina are of the same size. The upper cheekteeth and the auditory bullae are markedly smaller.

The tail appears to have been broken in the type since a paratype has the tail measuring 115 mm.

***Gerbillus (Dipodillus) principulus* (Thomas and Hinton)**

FIGURE 4,d

*Dipodillus principulus* Thomas and Hinton, Proc. Zool. Soc. London, p. 262, July 6, 1923. (El Malha, Jebel Meidob, Northern Darfur.)

SPECIMEN EXAMINED: The type.

MEASUREMENTS: The type, an adult female, measures as follows: Length of head and body 73; length of tail 115; length of hind foot 21; length of ear 11; greatest length of skull 26.1; condyloincisive length 22.6; length of anterior palatine foramina 4.0; crown length of upper tooththrow 3.4; length of auditory bullae 10.1; least interorbital width 4.5; greatest width across zygomatic arches 14.3; greatest breadth of skull 14.1.

REMARKS: The type is the only known specimen. In color it is very similar to *G. stigmatonyx* but has a smaller body with a tail equal to

or nearly equal to the latter. The skull is, in general, smaller, the cheekteeth are decidedly smaller, and the auditory bullae are markedly larger. The pterygoid fossae are less open and the anterior palatine foramina are shorter. In many respects *principulus* is like *watersi* and may eventually prove to be only a subspecies of that form.

***Gerbillus (Dipodillus) stigmonyx stigmonyx* (Heuglin)**

FIGURE 4,d

*Meriones stigmonyx* Heuglin, Reise in Nordost-Afrika, vol. 2, p. 78, 1877. (Khartoum.)

*Gerbillus stigmonyx luteolus* Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 8, p. 275, October 1901. (Duem.)

**SPECIMENS EXAMINED:** Seven, all in BM, from: Duem, 1; Khartoum, 5; El Kowa, 1.

**MEASUREMENTS:** An adult female from El Kowa has the following external measurements: Length of head and body 87; length of tail 104; length of hind foot 20. An adult male from Khartoum and the adult female above have, respectively, the following cranial measurements: Greatest length of skull 27.3, 26.5; condyloincisive length 24.8, 23.6; length of anterior palatine foramina 4.9, 4.7; crown length of upper toothrow 3.7, 3.8; length of auditory bullae 9.4, 9.4; least interorbital width 4.9, 4.9; length of nasals 9.9, 9.8; width of rostrum at level of antorbital foramen 2.9, 2.7; greatest width across zygomatic arches 14.2, 14.2; breadth of braincase 13.5, 13.6.

**REMARKS:** *Gerbillus s. stigmonyx*, when compared to *G. mackiligini*, shows a somewhat longer head and body and a shorter tail. The color is markedly lighter and the heavy brush on the tail found in the latter is not at all pronounced in the former. The skull is narrower at the back, the auditory bullae are markedly less inflated, the anterior palatine foramina are more open and somewhat shorter, the molars are heavier, and the pterygoid fossae are more open. The rostrum is decidedly heavier in *stigmonyx* and the infraorbital foramen is more open.

The type of *luteolus* differs neither in pelage characters nor cranially from any of the specimens from Khartoum, and, assuming the specimens from Khartoum to be topotypes of *G. stigmonyx*, the name *G. s. luteolus* described by Thomas from Duem must fall as a synonym.

***Gerbillus (Dipodillus) watersi* De Winton**

*Gerbillus (Dipodillus) watersi* De Winton, Nov. Zool., vol. 8, p. 399, December 1901. (Shendy, Upper Nile.)

**SPECIMENS EXAMINED:** Forty-two, all in BM, from: Shendy, 5; Kerma, 2; Shereik, 1; Atbara, 2; Merowe, 7; Khartoum, 10;  $\frac{1}{2}$  Abu

Fatima, 1; Port Sudan, 1; *Letti Basin*, 1; Khor Hanoieit, 4; eastern Egyptian desert, lat. 22° N., long. 35° E., 8.

MEASUREMENTS: An adult male from Shendy measures as follows: Length of head and body 67; length of tail 111; length of hind foot 22; length of ear 11; greatest length of skull 24.4; condyloincisive length 21.6; length of anterior palatine foramina 3.9; crown length of upper molar series 3.1; length of auditory bullae 9.4; least interorbital width 4.5; length of nasals 8.7; width of rostrum at level of antorbital foramen 2.5; greatest width across zygomatic arches 12.6; greatest breadth of braincase 12.5.

REMARKS: *Gerbillus watersi* may be distinguished from *G. stigmonyx* by its smaller body size but the same or nearly the same tail length and by the slightly redder color, except near the Red Sea where both species are nearly the same faded dun color. This same lightening in intensity of color is also seen in *G. pyramidum* and in *G. g. sudanensis*, both of which occupy the same geographic range.

The skulls of *watersi* may be separated from those of *stigmonyx* by their smaller size, less open pterygoid fossae, narrower rostra, smaller cheekteeth (relatively, as well as actually), larger bullae, and the smaller anterior palatine foramina of the former.

*Gerbillus gerbillus agag* Thomas

FIGURE 5,a

*Gerbillus agag* Thomas, Proc. Zool. Soc. London, p. 296, August 6, 1903. (Agageh Wells, western Kordofan.)

SPECIMENS EXAMINED: Twenty-one, all in BM, from: 25 miles west of En Nahud, 1; east of En Nahud, 1; 100 miles west of En Nahud, 2; 56 miles east of El Fasher, 1; Sayah, 60 miles northeast of El Fasher, 3; 55 miles north of El Fasher, 2; 40 miles west of El Fasher, 4; 90 miles northeast of El Fasher, 1; 105 miles northeast of El Fasher, 1; 19 miles north of El Fasher, 1; El Fasher, 2; Khartoum, 1; Umm Keddada, 1.

MEASUREMENTS: An adult male from El Fasher and an adult female from 19 miles north of El Fasher measure, respectively, as follows: Length of head and body 78, 80; length of tail 119, 113; length of hind foot ?, 23; length of ear 13, 14; greatest length of skull 29.0, 27.1; condyloincisive length 25.2, 23.3; length of anterior palatine foramina 5.2, 4.3; crown length of upper toothrow 3.9, 3.9; length of auditory bullae, 10.4, 9.6; least interorbital width 5.5, 5.4; length of nasals 11.1, 11.2; width of rostrum at level of antorbital foramen 3.0, 2.8; greatest width across zygomatic arches 14.0, 14.2; greatest breadth of braincase 13.8, 13.8.

REMARKS: The type of *G. g. agag* is an adult male from Agageh Wells. The standard external measurements are 87–100–24–11.

The skull, though, is so badly broken that no measurements can be taken that would be reliable.

In color and from what remains of the skull, the above specimens agree in all respects and in no way seem to vary from the species *gerbillus* except in the minor characters which are used as criteria for subspecies.

*Gerbillus gerbillus sudanensis*, new subspecies

FIGURE 5,a

TYPE: BM No. 29.5.19.16, adult male, skin and skull, from Port Sudan, Red Sea Province, Anglo-Egyptian Sudan. Obtained July 28, 1928, by E. W. Thomas, original No. 531.

SPECIMENS EXAMINED: Sixteen, all in BM, from: Kerma, 2; Merowe, 1; Wad Habushee, near Shendy, 1; Khor Mog, 2; Khor Hanoieit, 5; Port Sudan, 5.

DIAGNOSIS: Upperparts near Pinkish Cinnamon, purest on sides, flanks, and upper surface of nose. Ears, hands, feet, belly, cheeks to above eyes, postauricular spots, and ventral surface of tail white. Tail brush brownish. Soles of hind feet strongly haired with short white hairs. Skull with short anterior palatine foramina, small molariform teeth, moderately inflated auditory bullae, rostrum relatively short and narrow, nasals relatively short but narrow.

MEASUREMENTS OF TYPE SPECIMEN: Length of head and body 80; length of tail 120; length of hind foot 25; length of ear 12; greatest length of skull 26.2; condyloincisive length 22.4; length of anterior palatine foramina 3.7; crown length of upper toothrow 3.3; length of auditory bullae 9.9; least interorbital width 5.3; length of nasals 9.9; width of rostrum at level of antorbital foramen 2.8; greatest width across zygomatic arches 14.0; breadth of braincase 13.9.

COMPARISONS: From *G. g. agag*, *G. g. sudanensis* differs in lighter color, longer tail, and a brownish instead of blackish brush on the tail. The skull is smaller in all respects, the anterior palatine foramina are shorter, the molars are smaller, the rostrum is narrower and shorter, and the auditory bullae are not so inflated.

*G. g. sudanensis* may be distinguished from *G. g. gerbillus*, with which it apparently does not come into contact, by its smaller size and somewhat darker color.

REMARKS: There are no morphological differences between *sudanensis* and *agag* except in general size. It is for this reason that *sudanensis* is described as a subspecies of *G. gerbillus*. No intergradation has been demonstrated, but undoubtedly occurs.

*Gerbillus nancillus* Thomas and Hinton

*Gerbillus nancillus* Thomas and Hinton, Proc. Zool. Soc. London, p. 260, July 6, 1923. (Plains of Darfur, 45 miles north of El Fasher.)

SPECIMENS EXAMINED: Three, all in BM, from: Haraza, 1; 16 miles east of El Fasher, 1; 45 miles north of El Fasher, 1.

MEASUREMENTS: The measurements of the type, an adult female, are as follows: Length of head and body 54; length of tail 79; length of hind foot 17; length of ear 11; greatest length of skull 20.5; condyloincisive length 17.8; length of anterior palatine foramina 3.0; crown length of upper tooththrow 3.4; length of auditory bullae 7.4; least interorbital width 3.9; length of nasals 6.9; width of rostrum at level of antorbital foramen 2.4; breadth of braincase 10.8.

REMARKS: This diminutive gerbil is in color about like *G. g. agag*, but much smaller. The white on the nose, sides, cheeks, and postauricular spots is more extensive than in *agag*. The tail appears almost white except for the minute blackish brush on the distal one-third of the tail. This "brush" is scarcely deserving of the name since it is composed merely of blackish hairs a trifle longer than the lighter hairs meeting it.

*Gerbillus pyramidum pyramidum* E. Geoffroy

*Gerbillus pyramidum* E. Geoffroy, Catalogue des mammifères du Muséum National d'Histoire Naturelle, p. 202, 1803. (Near Pyramids of Giza, Giza Province, Egypt.)

*G[erbillus] burtoni* F. Cuvier, Trans. Zool. Soc. London, vol. 2, p. 145, May 4, 1838. ("Dahrfur"; according to Flower, the type was an animal which James Burton took to Paris alive in 1833.)

*Meriones dongolanus* Heuglin, Reise in Nordost-Afrika, vol. 2, p. 79, 1877 (Dongola.)

SPECIMENS EXAMINED: Sixty-eight, all in BM, from: Khartoum, 10; Erkowit, 5; Nubia, 1; Dongola, 3; Sabaluka, 2; Shendy, 11; Port Sudan, 4; Khor Hanoieit, 9; Shereik, 2; Kerma, 7; Hamza, 6; Haraza, 3; Merowe, 2; Tagbo Hills, 1; Jebel Meidob, 2.

MEASUREMENTS: An adult male and an adult female from Khartoum respectively measure as follows: Length of head and body 100, 109; length of tail 129, 135; length of hind foot 30, 30; length of ear 15, 15; greatest length of skull 31.7, 32.5; condyloincisive length 27.3, 28.1; length of anterior palatine foramina 5.7, 5.6; crown length of upper tooththrow 4.3, 4.4; length of auditory bullae 11.3, 11.2; least interorbital width 5.8, 6.1; length of nasals 12.1, 12.3; width of rostrum at level of antorbital foramen 3.3, 3.3; greatest width across zygomatic arches 16.6, 16.4; greatest breadth of braincase 15.6, 15.4.

REMARKS: Ellerman (1941, p. 509) lists the names *burtoni*, *pygargus*, and *dongolanus* as synonyms of the nominate form. It seems odd that other kinds of gerbils tend to form subspecies over this same area and yet this species does not.

When specimens from the Sudan are compared to topotypes from Giza, there is a decidedly lighter color which becomes progressively lighter as the Red Sea coast is approached. The animals from the Red Sea coast area have, in general, narrower molars than the typical animals but certain few have the teeth as large.

In specimens from Dongola, topotypes of *dongolanus* show no appreciable differences from typical *pyramidum* except in the narrowness of the molars.

A single specimen from Port Sudan is perhaps indicative of an undescribed species in that the auditory bullae are expanded beyond all proportion for *pyramidum* and the color of the pelage is markedly darker.

The specimens from Tagbo Hills and from Jebel Meidob are far paler in color than any other specimens seen. The skulls, however, agree with animals from other localities.

It is not possible, at this time, to tell whether or not one is dealing with several subspecies or merely clinal variation of a single subspecies occupying a vast geographic range. Material from intermediate localities is needed to clarify this problem. It seems rather probable that there is more than one subspecies concerned in the area.

#### *Gerbillus rosalinda* St. Leger

*Gerbillus rosalinda* St. Leger, Ann. Mag. Nat. Hist., ser. 10, vol. 4, p. 295, September 1929. (Abu Zabad, 145 km. southwest of El Obeid, Kordofan.)

SPECIMENS EXAMINED: Four, all in BM, from: Abu Zabad.

MEASUREMENTS: No external measurements are available, but the skull of an adult male from Abu Zabad measures as follows: Greatest length of skull 31.8; condyloincisive length 27.4; length of anterior palatine foramina 5.2; crown length of upper molar series 3.9; length of auditory bullae 11.4; least interorbital width 5.6; length of nasals 13.1; width of rostrum at level of antorbital foramen 3.3; greatest breadth of skull 15.5.

REMARKS: The color of the above specimens is a dark reddish brown with the white reduced markedly on the sides, cheeks, and supraorbital and postauricular spots. The color of the back is carried on to the dorsal surface of the tail until the black hairs of the brush begin. The brush occupies the distal one-third of the tail.

In size, *G. rosalinda* closely approaches *G. pyramidum*, but because of the smallness of the teeth, the conformation of the anterior palatine foramina, and the pterygoid structure it is retained as a separate species for the present.

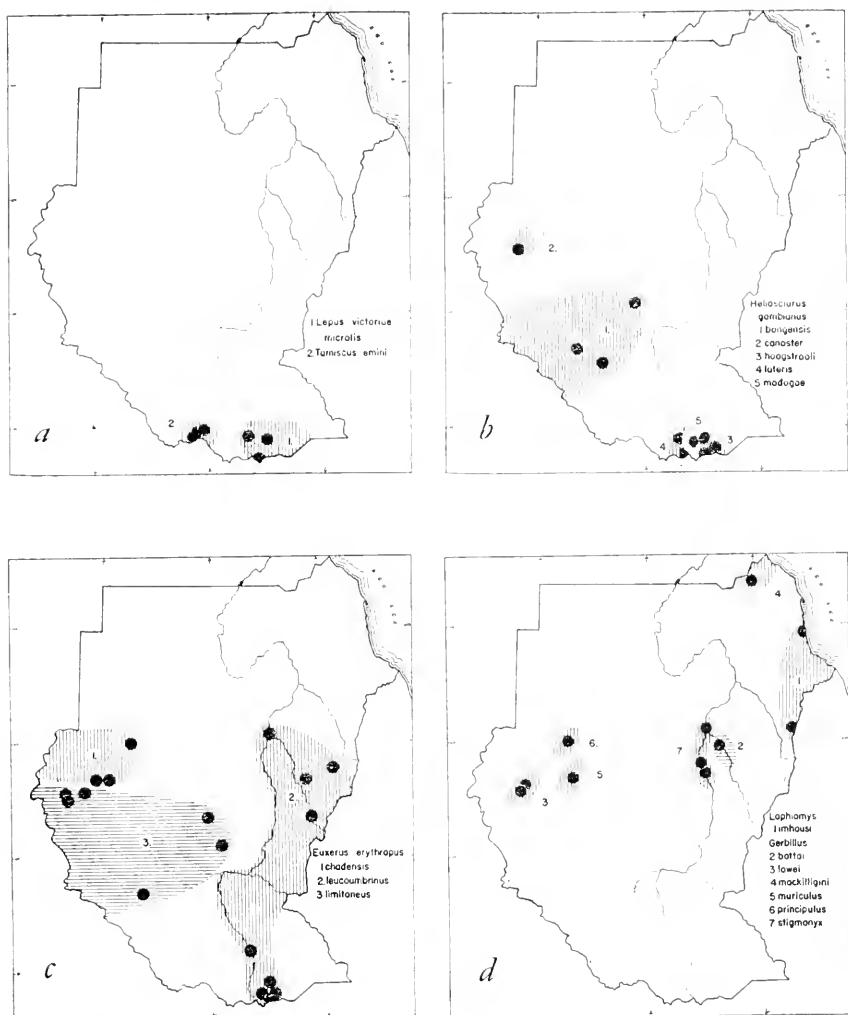


FIGURE 4.—Distribution of *Lepus* (in part), *Tamiscus*, *Heliosciurus*, *Euxerus*, *Lophomys* and *Gerbillus* (in part) in the Anglo-Egyptian Sudan. (Scale: 1 inch=400 miles.)

### *Tatera benvenuta benvenuta* (Hinton and Kershaw)

*Taterona benvenuta* Hinton and Kershaw, Ann. Mag. Nat. Hist., ser. 9, vol. 6, p. 97, July 1920. (Bahr-el-Jebel, Mongalla.)

**SPECIMENS EXAMINED:** Eighty-two, from: Torit, 40 (12, MCZ); Ikoto, 1; Obbo, 1; Nimule, 2; Juba, 2; *Magwe*, 36 miles southwest of Torit, 1 (MCZ); Murukurun, 50 miles east of Torit, 1 (MCZ); *Mura*, *Lofit Hills*, 1 (MCZ); Loa, 18 miles north of Nimule, 3 (MCZ); central Jebel Marra, 2 (BM); 40 miles north of Bor, 1 (BM); *Eros*, *Didinga Mts.*, 1 (BM); 60 miles west-southwest of El Fasher, 2 (BM); Bor, 1

(BM); foothills, southern Jebel Marra, 3 (BM); 40 miles west of El Fasher, 1 (BM); Duk Fagioil, 1 (BM); northeastern Jebel Marra, 1 (BM); *Kurra, northeastern Jebel Marra*, 1 (BM); Chak Chak, 3 (BM); Kulme, Wadi Aribo, 5 (BM); *Wadi Kongei, east-central Jebel Marra*, 3 (BM); Mongalla, 2 (BM); Um Dona, 1 (BM); Agur, 1 (BM); Delami, 1 (BM).

MEASUREMENTS: Average and extreme measurements, respectively, of ten males and three females from Torit are as follows: Length of head and body 160.6 (141–175), 147.5 (141–158); length of tail 159.6 (145–178), 167.5 (154–174); length of hind foot 37.1 (35–38), 37.5 (36–39); length of ear 21 (19–23), 20.5 (19–21); condyloincisive length of skull 35.5 (33.2–37.3), 35.3 (33.1–37.1); greatest length of skull 40.9 (38.2–43.4), 41.1 (38.6–43.1); greatest width across zygomatic arches 21.0 (20.2–22.2), 20.5 (19.5–21.5); least interorbital width 6.7 (6.4–7.0), 6.6 (6.4–6.8); length of nasals 16.1 (14.2–17.9), 16.3 (14.8–17.4); crown length of upper toothrow 6.4 (5.9–6.7), 6.4 (6.2–6.7); length of auditory bullae 11.4 (11.0–11.8), 11.3 (11.1–11.7); depth of braincase at level of auditory bullae 15.6 (14.9–16.3), 16.0 (15.8–16.4).

REMARKS: There is no detectable difference in the animals from Torit and those obtained from the Jebel Marra. The amount of variation in any given series is quite remarkable, especially as regards color. All specimens, though, show the lack of the tuft on the tail and the cranial characters are all within a normal range of variation for any given series. The amount of variation noted in color may be explained on the basis of seasonal difference.

*Tatera flavipes* G. M. Allen

*Tatera flavipes* G. M. Allen, Bull. Mus. Comp. Zool., vol. 58, p. 331, July 1914. (Aradeiba, above Roseires, Blue Nile.)

SPECIMEN EXAMINED: The type.

MEASUREMENTS: The type specimen, an adult female, measures as follows: Total length 343; length of tail 172; length of hind foot 40.5; length of ear 23; condyloincisive length of skull 40.5; greatest length of skull 44.0; greatest width across zygomatic arches 22.3; least interorbital width 7.4; length of nasals 16.9; crown length of upper tooth row 6.6; length of auditory bullae 12.2; depth of braincase at level of auditory bullae 16.9.

REMARKS: The dorsal color of *flavipes* is somewhat darker than *benvenuta*; the dorsal surface of the tail and the ears are darker; the tail is longer; and the hind foot is decidedly longer and wider. The upper cheekteeth are larger labiolingually; the auditory bullae are larger and more inflated; the rostrum is wider and longer; the upper



incisors are more proodont; the zygomatic arches are more angular; and the braincase is deeper and more rounded dorsally.

The type of *flavipes* is a younger animal than any of the specimens with which it was compared. In spite of its youthfulness it is larger than an adult of *benvenuta*, to which complex it definitely belongs. The tail in *flavipes*, like in *benvenuta* and *soror*, is untufted. This complex is indeed puzzling, and more material is needed to understand the problem of the relationships of these species.

***Tatera macropus* (Heuglin)**

FIGURE 5,b

*Meriones macropus* Heuglin, Reise in Nordost-Afrika, vol. 2, p. 79, 1877. (Bongo, Bahr-el-Ghazal region.)

SPECIMENS EXAMINED: Three, all in BM, from: Halfway between Chak Chak and Dem Zubeir, 2; near Chak Chak, 1.

MEASUREMENTS: An adult male from near Chak Chak has the following measurements: Length of head and body 180; length of tail 170; length of hind foot 35; length of ear 19; condyloincisive length of skull 32.2; greatest length of skull 38.2; greatest width across zygomatic arches 19.1; least interorbital width 6.6; length of nasals 15.5; crown length of upper toothrow 6.0; length of auditory bullae 10.2; depth of braincase at level of auditory bullae 15.2.

REMARKS: These animals are of a decidedly reddish color and have a pronounced tuft on the distal end of the tail. This brush is much more distinct than that in *T. robusta* to which *macropus* is obviously allied and which may eventually prove to be only a subspecies of the former.

***Tatera robusta robusta* (Cretzschmar)**

FIGURE 5,b

*Meriones robustus* Cretzschmar, in Rüppell, Atlas zu der Reise im nördlichen Afrika von Rüppell, pt. 1, Säugethiere, p. 75, 1826. (Kordofan.)

SPECIMENS EXAMINED: Thirty-seven, all in BM, from: Jebel Meidob, 4; Naikhala, Upper Egypt, 6; 6 miles west of El Fasher, 9; 40 miles west of El Fasher, 3; 40 miles west-southwest of El Fasher, 3; Kordofan, 1; 170 miles east of El Fasher, 1; 90 miles east of El Fasher, 1; Tina Wells, 1; 115 miles northeast of El Fasher, 1; 16 miles east of El Fasher, 1; En Nahud, 1; 55 miles north of El Fasher, 1; 52 miles west-southwest of El Fasher, 1; El Fasher, 1; 5 miles west of El Obeid, 2.

MEASUREMENTS: An adult male from Naikhala, Upper Egypt, measures as follows: Length of head and body 123; length of tail 170; length of hind foot 33; length of ear 17; condyloincisive length of skull 32.7; greatest length of skull 37.1; greatest width across zygomatic arches 18.2; least interorbital width 6.5; length of nasals 15.0;

crown length of upper toothrow 5.5; length of auditory bullae 9.9; depth of braincase at level of auditory bullae 13.6.

REMARKS: This species may be distinguished from *T. benvenuta* by its generally smaller size, lighter color, and conspicuous brush at the tip of the tail.

*Tatera robusta taylori* Hatt

FIGURE 5,b

*Tatera robusta taylori* Hatt, Amer. Mus. Nov., No. 791, p. 1, April 11, 1935.  
(Khor Birum, Red Sea Hills.)

SPECIMENS EXAMINED: Twenty, all in BM, from: Sinkat, 2; Soba, 6; El Kowa, 3; Shendy, 6; *Tamamiel*, 1; Roseires, 1; Sennaar, 1.

MEASUREMENTS: An adult male from Sinkat measures as follows: Length of head and body 129; length of tail 174; length of hind foot 37; length of ear 21; condyloincisive length of skull 32.0; greatest length of skull 39.6; least interorbital width 6.8; length of nasals 16.5; crown length of upper toothrow 5.9; length of auditory bullae 10.3; depth of braincase at level of auditory bullae 14.1.

REMARKS: This subspecies is somewhat paler in general, over-all color than is the nominate form from Kordofan. The auditory bullae are markedly less inflated and the anterior palatine foramina are shorter than in *robusta*. The hamulae are shorter and lighter in structure.

As the Nile or the Abyssinian highlands are approached, the color of the pelage tends to darken.

*Tatera soror* G. M. Allen

FIGURE 5,b

*Tatera soror* G. M. Allen, Bull. Mus. Comp. Zool., vol. 58, p. 333, July 1914.  
(Fazogli, Blue Nile.)

SPECIMEN EXAMINED: The type.

MEASUREMENTS: The type, an old adult female, measures as follows: Total length 299; length of tail 158; length of hind foot 34; length of ear 20; condyloincisive length of skull 34.6; greatest length of skull 38.4; greatest width across zygomatic arches 20.2; least interorbital width 6.4; length of nasals 16.3; crown length of upper toothrow 6.2; length of auditory bullae 10.2; depth of braincase at level of auditory bullae 14.3.

REMARKS: The species *soror* is the smallest of the species of *Tatera* occurring in the Sudan. The auditory bullae are small; the rostrum is narrow; and the cheekteeth are as wide as in *benvenuta* but not so massive as in *flavipes*. The anterior palatine foramina are markedly

short and narrow; the braincase is much flattened; the nasals are narrow but relatively long; and the lachrymal bone is small.

The type is an old adult with much-worn teeth. Hinton and Kershaw (1920, p. 99) considered *soror* to be a member of the *ben-renuta* complex, which seems to be correct. The tail in both *soror* and *flavipes* is untufted, but whether this is of significance in allocating species to groups is quite questionable.

### Genus *Taterillus* Thomas

So far as can be determined at this time, there is no character by which *emini*, *anthonyi*, *butleri*, *rufus*, *perluteus*, and *clivosus* can be distinguished as species.

Hatt (1934, p. 3) mentions integradation of *anthonyi* with *butleri*, and in certain specimens from Delami, Nuba Mountains, there is what appears to be integradation with *rufus*.

While no actual intergradation can be demonstrated between *gyas* and any of the contiguous kinds, there are certainly no morphological differences to warrant retention of this form as a full species.

The peripheral kinds, *gyas*, *emini*, and *clivosus*, are all dark in color, while those in the center of the area under consideration are paler and ending in the palest of the group in *perluteus*.

Hatt (1934, p. 3) when describing *anthonyi*, referred to the species *congius* as a subspecies of *T. emini*. From the degree of morphological difference, and owing to the fact that specimens from Wau are immediately separable as *T. e. butleri* and as *T. congius*, I feel that *congius* should stand as a full species until its relationship with an allied species, *T. nigeriae*, has been clarified. It is certainly not a part of the complex known as the *emini* group.

Since *T. rufus* and *T. butleri* are shown to be only subspecies of one species, the name *Gerbillus (Taterina) lorenzi* Wettstein, which has been considered synonymous with *T. butleri*, should be transferred to the synonymy of *T. e. rufus* which shares its type locality but has page preference.

Color, as such, in these gerbils is relatively constant but there is some divergence in one given population such as may be seen in specimens from the vicinity of El Fasher and from Torit. In comparison with the degree of variation found in the crania (in regard to the auditory bullae, the lateral bowing of the anterior palatal foramina, and other characters) color varies not at all. It is only by comparing the skin and the skull with known specimens that one can arrive at any satisfactory determination.

*Taterillus congicus* Thomas

FIGURE 5,b

*Taterillus congicus* Thomas, Ann. Mag. Nat. Hist., ser. 8, vol. 16, p. 147, August 1915. (Poko, Upper Uele River, Belgian Congo.)

SPECIMENS EXAMINED: Three, all in BM, from: Wau, 2; Yei, 1.

MEASUREMENTS: The measurements of an adult male from Yei are as follows: Length of head and body 120; length of tail 140; length of hind foot 33; length of ear 19; condyloincisive length of skull 30.3; greatest length of skull 35.6; length of nasals 14.2; least interorbital width 6.3; length of anterior palatine foramina 6.2; crown length of upper toothrow 5.0; length of auditory bullae 9.0; depth of skull at level of auditory bullae 13.8; greatest width across zygomatic arches 17.2; greatest width of skull 16.3.

REMARKS: *T. congicus* differs from *T. emini* and its subspecies in that the pterygoid fossae are deeper and not so widely flaring, anterior palatine foramina are relatively shorter, the auditory bullae are more inflated anteriorly and antero-laterally, and the anterior portion of the skull is flatter and less decurved. So far as color is concerned there is no discernible difference between the two species. However, when specimens from the same locality are compared they are readily separable by means of the skull.

*Taterillus emini anthonyi* Hatt

FIGURE 5,c

*Taterillus emini anthonyi* Hatt, Amer. Mus. Nov., No. 708, p. 2, Apr. 4, 1934. (White Nile, west bank, 20 miles south of Jebel Ain.)

SPECIMEN EXAMINED: The type.

MEASUREMENTS: The type, an adult female, measures as follows: Total length 316; length of tail 182; length of hind foot 35; condyloincisive length of skull 33.1; length of nasals 14.7; least interorbital breadth 7.3; length of anterior palatine foramina 7.1; crown length of upper toothrow 4.9; length of auditory bullae 10.0; depth of skull at level of auditory bullae 14.4; greatest width across zygomatic arches 15.8.

REMARKS: The type and one paratype are the only known examples of this subspecies. Hatt, in comparing these two specimens with types in the British Museum, remarked that these were strikingly different but specimens in the British Museum from intermediate localities suggested complete intergradation. It is quite apparent to me also that intergradation does occur with the form immediately to the west, which is *rufus*. For additional remarks see under *T. e. rufus*.

*Taterillus emini butleri* Wroughton

FIGURE 5,c

*Taterillus butleri* Wroughton, Ann. Mag. Nat. Hist., ser. 9, vol. 6, pp. 293-294, September 1910. (Dugdug, Bahr-el-Ghazal.)

*Gerbillus (Taterillus) kadugliensis* Wettstein, Anz. K. Akad. Wiss. Wien, Math.-Nat., vol. 53, p. 151, 1916. (Kadugli, southern Kordofan.)

SPECIMENS EXAMINED: Ten, all in BM, from: Dugdug, 3; Katta, northwest of Wau, 2; Wau, 1; Raffili, 4.

MEASUREMENTS: The measurements of the type, an adult female from Dugdug, are as follows: Length of head and body 120; length of tail 150; length of hind foot 29; length of ear 18; condyloincisive length of skull 30.1; greatest length of skull 34.6; length of nasals 14.1; least interorbital width 6.3; length of anterior palatine foramina 6.9; crown length of upper toothrow 4.7; length of auditory bullae 9.0; depth of skull at level of auditory bullae 13.6; greatest width across zygomatic arches 15.9.

REMARKS: For remarks see under the heading of genus *Taterillus*.

*Taterillus emini clivosus* Thomas and Hinton

FIGURE 5,c

*Taterillus clivosus* Thomas and Hinton, Proc. Zool. Soc. London, p. 258, July 6, 1923. (Kurra, Jebel Marra.)

SPECIMENS EXAMINED: Nineteen, all in BM, from: Jebel Marra, 1; Kurra, northeastern Jebel Marra, 11; Kulme, Wadi Aribo, 7.

MEASUREMENTS: An adult female from Kurra, northeastern Jebel Marra, has the following measurements: Length of head and body 120; length of tail 171; length of hind foot 32; length of ear 18; condyloincisive length of skull 31.3; length of nasals 14.9; least interorbital width 6.3; length of anterior palatine foramina 6.3; crown length of upper toothrow 5.2; length of auditory bullae 9.6; depth of skull at level of auditory bullae 14.0; greatest width across zygomatic arches 18.8; greatest breadth of skull 16.8.

REMARKS: The type, a specimen from Kurra, is aberrant from the rest of the type series in that it is somewhat darker dorsally and has a white tip on the tail. However, the skulls all agree in fundamental details.

One specimen from Kurra, northeastern Jebel Marra, is an apparent intergrade between *clivosus* and *T. e. perluteus*. In color the specimen is intermediate, in the shape of the auditory bullae it is like the latter, and in size it is like the former. In the majority of the cranial characters it is more nearly like *clivosus*.

The series from Kulme, Wadi Aribo, is consistently darker than the type, but in cranial features it is identical with the type.

*Taterillus emini emini* (Thomas)

FIGURE 5,c

*Gerbillus emini* Thomas, Ann. Mag. Nat. Hist., ser. 6, vol. 9, p. 78, January 1892.  
(Wadelai, Uganda.)

SPECIMENS EXAMINED: Sixty-two, from: Torit, 34 (13, MCZ); Obbo, 6; Ikoto, 1; Moli, 30 miles north of Nimule, 3 (MCZ); Juba, 1 (BM); Malek, 14 (BM); Mongalla, 2 (BM); "*Upper Nile*," 1 (BM).

MEASUREMENTS: Averages and extremes for three adult males and three adult females from Torit, are as follows: Length of head and body 119 (106–130), 113 (99–124); length of tail 153 (150–157), 153 (145–160); length of hind foot 32.6 (31–34), 32.6 (31–34); length of ear 18.6 (17–19), 18.6 (18–19); condyloincisive length of the skull 28.0 (27.6–28.4), 28.8 (28.3–29.7); greatest width across zygomatic arches 18.4 (17.8–19.2), 18.1 (17.9–18.2); least interorbital width 6.2 (5.9–6.4), 6.1 (5.9–6.3); length of nasals 13.7 (13.3–14.0), 14.1 (13.7–14.7); crown length of upper toothrow 4.9 (4.7–5.0), 4.9 (4.8–5.0); length of auditory bullae 9.3 (9.0–10.0), 9.1 (8.8–9.4); depth of skull at level of auditory bullae 14.1 (13.8–14.5), 13.9 (13.7–14.0).

REMARKS: The two specimens from Mongalla are much redder in color than are any of the other specimens assigned to this subspecies. This deepening of color, however, appears to be caused by old worn pelage exposing more of the subterminal band of color.

*Taterillus emini gyas* Thomas

FIGURE 5,c

*Taterillus gyas* Thomas, Ann. Mag. Nat. Hist., ser. 9, vol. 2, p. 150, August 1918.  
(Kamisa, Dinder River.)

SPECIMENS EXAMINED: Six, all in BM, from Kamisa.

MEASUREMENTS: The type, an adult female, measures as follows: Length of head and body 127; length of tail (not the type) 175; length of hind foot 34; length of ear 21; condyloincisive length of the skull 35.0; greatest length of the skull 39.0; greatest breadth across zygomatic arches 19.5; length of nasals 15.6; least interorbital breadth 7.3; length of anterior palatine foramina 7.2; length of auditory bullae 10.2; crown length of upper molar series 5.5.

REMARKS: See under the heading of genus *Taterillus*.

*Taterillus emini perluteus* Thomas and Hinton

FIGURE 5,c

*Taterillus perluteus* Thomas and Hinton, Proc. Zool. Soc. London, p. 259, July 6, 1923. (Umm Keddada.)

SPECIMENS EXAMINED: Twenty-three, all in BM, from: Umm Keddada, 5; 35 miles north of El Fasher, 1; 190 miles east of El

Fasher, 1; *Hamza*, 1; El Fasher, 2; 110 miles east of El Fasher, 1; *Madu*, 80 miles east of El Fasher, 1; 60 miles west of El Fasher, 2; 49 miles west-southwest of El Fasher, 3; 35 miles west-southwest of El Fasher, 1; near Tagbo Hills, 1; 25 miles east of En Nahud, 2; Jebel Meidob, 2.

MEASUREMENTS: An adult female from Umm Keddada, measures as follows: Length of head and body 116; length of tail 151; length of hind foot 29; length of ear 21; condyloincisive length of skull 31.3; greatest length of skull 36.8; length of nasals 15.0; least interorbital width 6.4; length of anterior palatine foramina 6.0; crown length of upper toothrow 5.0; length of auditory bullae 10.4; depth of skull at level of auditory bullae 14.1; breadth of braincase 16.6.

REMARKS: Intergradation with *T. e. rufus* is noted in the two specimens from near En Nahud in the intermediacy of color and in the shape and degree of inflation of the auditory bullae. The same characters indicate intergradation in the specimens from west-southwest of El Fasher with *clivosus*.

*Taterillus emini rufus* (Wettstein)

FIGURE 5,c

*Gerbillus (Tatera) rufa* Wettstein, Anz. K. Akad. Wiss. Wien, Math.-Nat., vol. 53, p. 131, 1916. (El Obeid.)

*Gerbillus (Taterina) lorenzi* Wettstein, Anz. K. Akad. Wiss. Wien, Math.-Nat., vol. 53, p. 152, 1916. (El Obeid.)

SPECIMENS EXAMINED: Twenty-two, all in BM, from: 20 miles west of El Obeid, 1; 50 miles west of El Obeid, 4; Agur, 6; Nuba Mountains, 5; Delami, 5; Um Dona, 1.

MEASUREMENTS: An adult male from 20 miles west of El Obeid, measures as follows: Length of head and body 130; length of tail 175; length of hind foot 32; length of ear 21; condyloincisive length of skull 33.0; length of nasals 15.6; least interorbital width 6.9; length of anterior palatine foramina 7.1; crown length of upper toothrow 5.1; length of auditory bullae 10.1; depth of skull at level of auditory bullae 14.5; breadth of braincase 16.4.

REMARKS: Specimens from the Nuba Mountains appear to be intermediate in several characters between *T. e. butleri* and *T. e. rufus*. This intermediacy is demonstrated in the color of the pelage and the size and shape of the auditory bullae. In all other characters of the skull, though, they are more nearly like *rufus*.

The five specimens from Delami appear to be intergrades in color and size with *T. e. anthonyi*.

Hatt (1934, p. 3) states that specimens from 50 miles west of El Obeid are in many respects intermediate between *T. e. butleri* and *T. e. anthonyi*. Apparently Hatt overlooked the paper by Wettstein

in 1916 in which he proposed the name *rufus* with the type locality at El Obeid. Certainly the material available for study has shown that the animals from the vicinity of El Obeid are different than any of the surrounding kinds and that the name *rufus* should stand. It is also apparent that the name *T. e. anthonyi* is valid but that the range of this subspecies lies between the Nile and the Nuba Mountains, where the characters of *rufus* and *anthonyi* blend.

***Desmodilliscus braueri* Wettstein**

*Desmodilliscus braueri* Wettstein, Anz. K. Akad. Wiss. Wien, Math.-Nat., vol. 53, p. 153, 1916. (Between Um Ramad and Nubbaka, south of El Obeid, Kordofan.)

**SPECIMENS EXAMINED:** Two, both in BM, from: 75 miles west of El Obeid, 1; 140 miles east of El Fasher, 1.

**MEASUREMENTS:** An adult male from 75 miles west of El Obeid measures as follows: Length of head and body 57; length of tail 45; length of hind foot 15; greatest length of skull 21.8; condyloincisive length 18.5; crown length of upper toothrow 2.9; length of auditory bullae 9.3; least interorbital width 4.0; length of nasals 7.7; width of rostrum at level of antorbital foramen 2.6.

**REMARKS:** This is a small, short-tailed, silky furred mouse with pronounced postauricular white spots. The hind feet are long in proportion to the body. The skull is small but robust and with the auditory bullae occupying an inordinate amount of the total size. The bullae are readily visible from above and encompass the condyles below. Both pairs of palatine foramina are long and wide open.

***Meriones libycus pallidus* Bonhote**

*Meriones crassus pallidus* Bonhote, Abstr. Proc. Zool. Soc. London, No. 103, p. 3, February 13, 1912. (Atbara.)

**SPECIMENS EXAMINED:** Eight, all in BM, from: Atbara, 3; Berber, 2; Shereik, 1; Kerma, 2.

**MEASUREMENTS:** An adult male and an adult female from Atbara measure, respectively, as follows: Length of head and body 127, 126; length of tail 110, 130; length of hind foot 28, 31; length of ear 17, 16; greatest length of skull 39.9, 38.5; condyloincisive length 35.4, 33.5; crown length of upper toothrow 4.9, 4.8; length of auditory bullae 16.4, 16.1; greatest width across zygomatic arches 21.1, 19.5; least interorbital width 6.5, 5.8; length of nasals 14.3, 14.3; breadth of braincase 22.2, 21.5.

**REMARKS:** The genus *Meriones* is a North African element penetrating along with the desert into northern Sudan from Egypt. Its main distribution lies to the north and east into western Asia.



The two specimens from Kerma are somewhat paler in color than are the animals from Atbara. This may be due to a difference in pelage owing to season. The skulls, however, present no peculiarities.

*Psammomys obesus elegans* Heuglin

*Psammomys elegans* Heuglin, Reise in Nordost-Afrika, vol. 2, p. 80, 1877. (Suakin.)

SPECIMENS EXAMINED: Four, all in BM, from Port Sudan.

MEASUREMENTS: An adult male and an adult female from Port Sudan measure, respectively, as follows: Length of head and body 162, 140; length of tail 136, 125; length of hind foot 35, 31; length of ear 13, 11; greatest length of skull 39.8, 38.8; condyloincisive length 36.1, 35.9; crown length of upper toothrow 5.9, 5.9; length of auditory bullae 13.7, 13.4; greatest width across zygomatic arches 22.5, 22.4; least interorbital width 6.6, 6.5; length of nasals 13.8, 13.7; greatest breadth of braincase 22.7, 22.8.

REMARKS: These specimens are quite reddish and lack the black wash on the dorsal surface of the body which is so typical of other members of the genus. The belly is decidedly lighter in color but still heavily washed with buff. The hands and feet are as the color of the belly, the black tip of the tail occupies about one-fourth of the total length.

Ellerman (1951, p. 538) considers *elegans* to be a synonym of *obesus*. This is not the case, however. The population, as judged by the specimens from Port Sudan, vary to the same degree from typical *obesus* as does *nicolli*. Although no actual intergradation can be demonstrated from the few specimens available, I cannot agree with Allen (1939, p. 330) that this is a good species nor can I agree with Ellerman (loc. cit.) that this a synonym of *obesus*. Thus I prefer to express its taxonomic position in the above combination.

In general, these animals resemble *Meriones* but are grosser in appearance. The skulls are grosser, the incisor faces are plain, the bullae are not so inflated ventrally, and the suprameatal triangle is nearly obliterated.

Family MURIDAE

Subfamily Murinae

*Grammomys macmillani erythropygus*, new subspecies

FIGURE 5,d

TYPE: CNHM No. 67061, adult male, skin and skull, from Obbo, Torit District, Anglo-Egyptian Sudan. Obtained March 22, 1950, by Harry Hoogstraal, original No. 5321.

SPECIMENS EXAMINED: Sixty-three, from: Malek, 1 (BM); *Obbo*, 37; *Torit*, 19 (4, MCZ); Lokwi, 25 miles southwest of Torit, 1; *Katire*,

1; Ngaboli, 47 miles north of Torit, 1 (MCZ); *Ngabara, near Obbo*, 1 (MCZ); *Talanga Forest, Imatong Mountains*, 1 (MCZ); Gilo, Imatong Mountains, 1 (MCZ).

DIAGNOSIS: Upperparts of mixed coloration; anteriorly grayish brown with some admixture of Sayal Brown gradually shading at about the middle of the back into primarily Sayal Brown intermixed with black-tipped hairs, thus presenting a "2-toned" appearance; color of anterior and posterior parts of the dorsum shading over the sides into a neutral grayish color which is bordered ventrally by a thin line of Pinkish Buff extending from the forearm along the sides and over the flanks onto the lower leg. Upper lips, under side of forelegs, under parts of thighs and entire belly pure white; tail brownish and indistinctly bicolor. Skull relatively large and robust; dorsal outline relatively flat, rostrum short and broad, anterior palatine foramina relatively short, and auditory bullae relatively large.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 107; length of tail 180; length of hind foot 25; length of ear 20; greatest length of skull 29.3; condylobasal length 24.5; least interorbital width 4.5; length of nasals 10.4; crown length of upper toothrow 4.4.

COMPARISONS: *G. m. erythropygus* is in color like *G. s. elgonis*, but the skull is flatter, the upper cheek teeth are wider, the auditory bullae are somewhat larger, anterior palatine foramina are shorter, and the basioccipital is narrower.

The present-named form is like the type and a paratype of *G. m. gazellae* in color but the skull is larger in all measurements taken except for the length of the anterior palatine foramina, which are shorter.

*G. m. erythropygus* differs from the type of *G. macmillani* in that the color is less intense and does not extend so far forward on the body. The skull of the former is larger, the anterior palatine foramina are longer, the posterior choanae are wider and longer, the auditory bullae are larger, and the palate is somewhat wider.

From the type of *G. surdaster*, *G. m. erythropygus* differs in less intense color, the skull is flatter in dorsal outline, the auditory bullae are somewhat larger, the anterior palatine foramina are narrower and longer, and the rostrum is somewhat heavier.

The color of *G. m. aridulus* is decidedly paler than is *G. m. erythropygus*. The skull is about the same size but *aridulus* has the anterior palatine foramina somewhat shorter and the zygomatic arches are somewhat heavier.

From a paratype of *G. s. polionops* the present subspecies differs in a lighter color throughout. The skulls are larger, the anterior palatine foramina longer, the posterior choanae wider, the palate is wider, the

auditory bullae are somewhat larger, and the rostrum is somewhat heavier.

REMARKS: From the degree of variation as may be noted in the section on comparisons, it is apparent that none of the characters formerly used to separate *G. macmillani* and *G. surdaster* are of more than subspecific worth. The characters usually associated with *surdaster* may be found in the types of *macmillani* and the converse is also true. I feel, therefore, since these characters are duplicated and do overlap to a great degree, that the animals formerly known as *surdaster* should now be called *macmillani*. The names in question are: *Grammomys macmillani surdaster*, *G. m. insignis*, *G. m. polionops*, *G. m. littoralis*, *G. m. callithrix*, and *G. m. discolor*.

***Grammomys macmillani aridulus* Thomas and Hinton**

FIGURE 5,d

*Grammomys aridulus* Thomas and Hinton, Proc. Zool. Soc. London, p. 268, July 6, 1923. (Kulme, Wadi Aribo.)

SPECIMEN EXAMINED: The type.

MEASUREMENTS: The type, an adult male, measures as follows: Length of head and body 115; length of tail 175; length of hind foot 24; length of ear 18; greatest length of skull 29.4; condylobasal length 24.6; zygomatic width 14.3; least interorbital width 4.5; length of nasals 11.0; crown length of upper toothrow 4.3.

REMARKS: *G. m. aridulus* is the palest of any of the subspecies of this genus occurring in the Sudan. The anterior palatine foramina are shorter than in any of the other kinds.

Since the type is the only known specimen, it is with some misgiving that I assign it to the species *macmillani*. However, in all of the characters of the skull and skin there is no one character by which it might be accorded specific rank and by assigning the type to this species probably more nearly expresses the true relationship.

***Grammomys macmillani gazellae* (Thomas)**

FIGURE 5,d

*Thamnomys macmillani gazellae* Thomas, Ann. Mag. Nat. Hist., ser. 8, vol. 5, p. 282, March 1910. (Chak Chak, Bahr-el-Ghazal.)

SPECIMENS EXAMINED: Six, all in BM, from: Bendele, Yambio District, 1; "Upper Nile," 1; Tembura, 1; Chak Chak, 2; *Loavie, near Fort Berkeley*, 1.

MEASUREMENTS: The measurements of an adult male paratype from Chak Chak are as follows: Length of head and body 105; length of tail 165; length of hind foot 28; greatest width across zygomatic

arches 13.0; least interorbital width 4.1; length of nasals 9.6; crown length of upper toothrow 4.0.

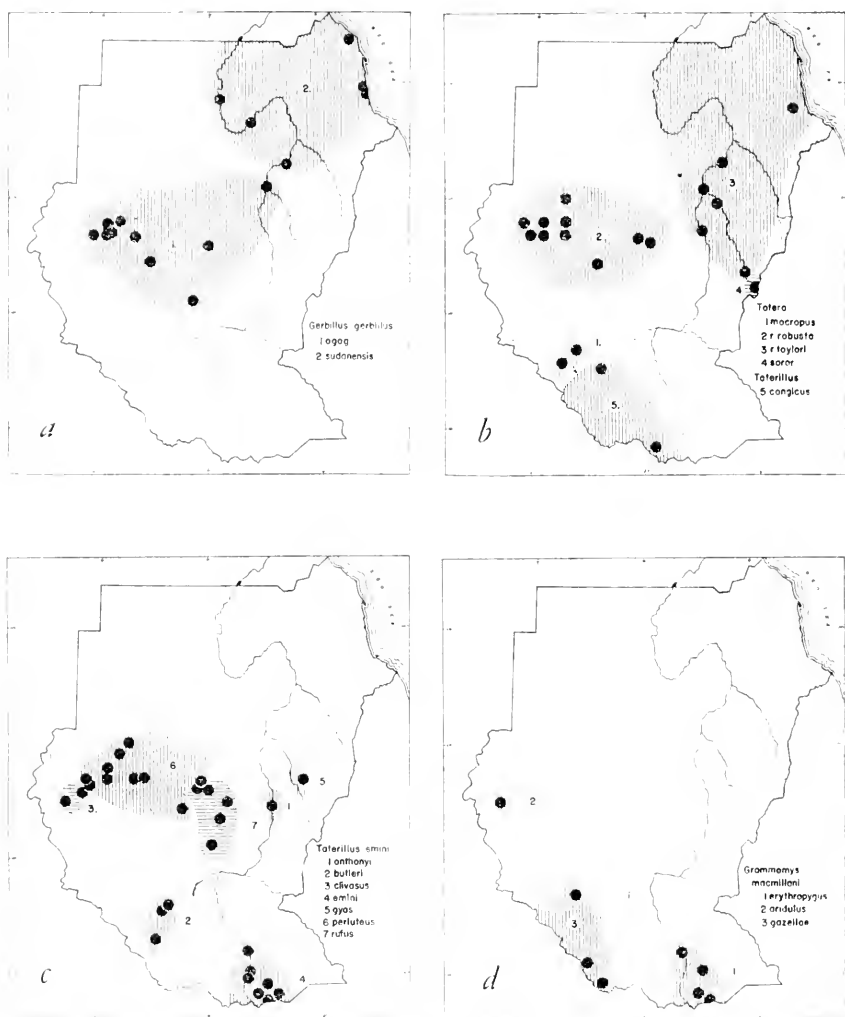


FIGURE 5.—Distribution of *Gerbillus* (in part), *Tatera*, *Taterillus*, and *Grammomys* in the Anglo-Egyptian Sudan. (Scale: 1 inch=400 miles.)

REMARKS: Both the type and the paratype of this subspecies have broken skulls so that no complete measurements are possible. This subspecies seems to be the smallest of the group found in the Sudan.

Apparently the distribution of this form lies to the west of the Nile and to the east of the Jebel Marra. While no actual intergradation of the various kinds has actually been demonstrated, they are here

considered all to belong to one species since the characters for each of them show a considerable degree of overlapping.

*Oenomys hypoxanthus talangae*, new subspecies

TYPE: MCZ No. 45315, adult female, skin and skull, from Talanga Forest, 3,000 ft., Imatong Mountains, Equatoria Province, Anglo-Egyptian Sudan. Obtained July 10, 1950, by J. S. Owen, original No. 1338.

SPECIMENS EXAMINED: Two, from the Talanga Forest.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 175; length of tail 203; length of hind foot 34; greatest length of skull 39.6; condyloincisive length 35.4; length of anterior palatine foramina 7.6; crown length of upper tooththrow 6.6; least interorbital width 5.4; breadth of rostrum at level of antorbital foramen 5.0; length of nasals 15.8; greatest width across zygomatic arches 17.9.

DIAGNOSIS: General over-all color of upperparts near Argus Brown; the line of pure color separating dorsal color from pure white belly and pure color on flanks and thighs near Pinkish Cinnamon; pure color of nose near Tawny; entire underparts and undersurfaces of arms and legs pure white, all hairs white to base; tail nearly naked and rather uniformly colored; hands and feet dark grayish brown. Skull relatively long and slender; nasals long and rather wide; rostrum wide; auditory bullae relatively small; upper cheekteeth relatively small; anterior palatine foramina relatively short and widely flaring; braincase relatively long.

COMPARISONS: From *Oenomys hypoxanthus unyori*, *O. h. talangae* differs in much darker dorsal color, less rufous on the rump, and less definite line of demarcation between the dorsal color and the pure white belly. The nasals are longer, the braincase is longer, the anterior palatine foramina are larger, the auditory bullae are larger, and the rostrum is narrower.

*O. h. talangae* differs from *O. h. editus* in generally darker color and less rufous on the nose and rump. The skull has longer nasals, smaller auditory bullae, and a wider rostrum.

*O. h. vallicola* differs from *O. h. talangae* in generally lighter color, more rufous on rump and nose, shorter tail, and somewhat larger ears. The skull is smaller, the upper tooththrow longer and the individual teeth wider, the anterior palatine foramina longer and narrower, auditory bullae larger, and the rostrum shorter and narrower.

REMARKS: The subspecies to which *O. h. talangae* is most closely related is *O. h. unyori*, from which it differs as set forth above. It is interesting that this new subspecies has the rufous of the rump and nose so much reduced. The types of *bacchante*, *moerens*, and *oris* are all so brightly colored that *talangae* needs no comparison with them.

*Myiomys cunninghami christyi* Thomas

*Myiomys christyi* Thomas, Ann. Mag. Nat. Hist., ser. 8, vol. 20, p. 362, November 1917. (Mount Baginzi, Bahr-el-Ghazal.)

SPECIMENS EXAMINED: Two, both in BM, from Mount Baginzi.

MEASUREMENTS: No external measurements are available for a male, but an adult female from Mount Baginzi measures as follows:

Length of head and body 135; length of tail 140; length of hind foot 34; length of ear 19.

The cranial measurements of an adult male and the same female above are, respectively, as follows: Greatest length of skull 31.4, 33.4; condyloincisive length 28.8, 30.8; crown length of upper toothrow 14.8, 16.0; greatest width across zygomatic arches 7.7, 7.2; least interorbital width 4.1, 4.6; length of nasals 12.4, 12.8; width of rostrum at level of antorbital foramen 4.0, 4.3.

REMARKS: All of the kinds of *Myiomys* have a grizzled appearance on the dorsum similar to that found in *Arvicanthis*, but the hairs are longer and much glossier than in that genus. The tail is more pronouncedly bicolor and the belly is covered with pure white hairs which are white to the base.

*M. c. christyi* differs from *M. c. lutescens* in somewhat smaller skull, shorter toothrow, narrower anterior palatine foramina, more open posterior choanae, and smaller auditory bullae.

*M. c. christyi* differs from *M. c. cunninghami* in the same way except for the posterior choanae which are smaller and the rostrum which is shorter and narrower.

*Dasymys incomtus palustris*, new subspecies

FIGURE 6,a

TYPE: CNHM No. 73902, skin and skull, adult male, from Lokwi, 25 miles south of Torit, Equatoria Province, Anglo-Egyptian Sudan. Obtained in June 1952 by J. S. Owen, original No. 2220.

SPECIMENS EXAMINED: Five, from: Lokwi, 25 miles south of Torit, 3; Mongalla, 2 (BM).

DIAGNOSIS: General over-all color of upperparts near Snuff Brown, strongly intermixed with black; no pure color at any place except a thin subterminal band which is near Tawny-Olive. Hands and feet light brownish, tail dark brown and uniformly colored, entire underparts grayish white. Skull relatively small, anterior palatine foramina relatively large, nasals short, zygomatic arches quite flaring posteriorly, bullae relatively small, upper cheekteeth relatively small.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 150; length of tail 140; length of hind foot 34; length of ear 16; con-

dyloincisive length of skull 34.7; crown length of upper toothrow 7.2; length of anterior palatine foramina 7.9; greatest width across zygomatic arches 19.6; least interorbital width 4.8; length of nasals 12.6; width of rostrum at level of antorbital foramen 4.1.

COMPARISONS: From *Dasymys incomtus helukus*, *D. i. palustris* differs in lighter color, that is, more red and less yellow and brown, and belly with no buffy wash as in *helukus*. Skull is smaller, auditory bullae smaller, rostrum shorter, upper cheekteeth smaller, least interorbital width greater, and nasals shorter.

*D. i. palustis* differs from *D. i. nigrinus* in the same manner as from *D. i. helukus* and is even markedly lighter in color.

From *D. i. savannus*, *D. i. palustris* differs in having no buffy wash on the belly and in having a small skull, markedly smaller auditory bullae, shorter rostrum, and shorter nasals.

*D. i. shawi* differs from *D. i. palustris* in darker color, smaller auditory bullae, and longer anterior palatine foramina.

*D. i. palustris* differs from *D. orthos* in having a longer tail, generally redder color, and lacking the olivaceous wash on the belly. The skull has a narrower rostrum, smaller, more elongate, less inflated auditory bullae, more flaring zygomatic arches, shorter nasals, narrower interorbital region, markedly larger and longer anterior palatine foramina, and the anterior edge of the zygomatic plate being concave instead of relatively straight as in *orthos*.

REMARKS: I am inclined to agree with Ellerman that the former species of *Dasymys* are in reality only one species with an infinite amount of variation. This probably includes even *orthos*, but until such time as the significance of the straight anterior edge of the zygomatic plate is understood it is probably better to treat that species as such. Certainly, in all of the specimens examined from most of the range of the genus, that peculiarity is outstanding.

From the material available it appears that *orthos* is not a part of the fauna of the southern Sudan.

*Dasymys incomtus shawi* Kershaw

FIGURE 6,a

*Dasymys shawi* Kershaw, Ann. Mag. Nat. Hist., ser. 9, vol. 13, p. 25, January 1924. (Mount Baginzi, southern Bahr-el-Ghazal, near Congo border, 40 miles south-southeast of Yambio.)

SPECIMENS EXAMINED: Two, both in BM, from: 40 miles south-southeast of Yambio, 1; Yambio district, 1.

MEASUREMENTS: The type, an adult male, measures as follows: Length of head and body 152; length of tail 144; length of hind foot 29; length of ear 19; condyloincisive length of skull 34.2; crown length of upper toothrow 6.6; length of anterior palatine foramina 7.6; great-

est width across zygomatic arches 17.4; least interorbital width 4.4; length of nasals 12.3; width of rostrum at level of antorbital foramen 3.9.

REMARKS: This subspecies is a saturate form which differs from other adjacent named kinds as set forth under the comparisons section for *D. i. palustris*.

*Arycanthis niloticus centralis* Dollman

FIGURE 6,b

*Arricanthis testicularis centralis* Dollman, Ann. Mag. Nat. Hist., ser. 8, vol. 8, p. 338, September 1911. (Between Chak Chak and Dem Zubeir, Bahr-el-Ghazal.)

SPECIMENS EXAMINED: Seventeen, all in BM, from: Between Chak Chak and Dem Zubeir, 1; Chak Chak, 2; Meridi, 3; Yei, 1; Temburas, 1; Kulme, Wadi Aribo, 2; *Kurro*, *Jebel Marra*, 2; Zalingei, 5.

MEASUREMENTS: The type, an adult male, measures as follows: Length of head and body 145; length of tail 143; length of hind foot 33; length of ear 19; greatest length of skull 37.0; condyloincisive length 34.2; length of anterior palatine foramina 6.6; crown length of upper toothrow 6.4; greatest width across zygomatic arches 18.5; least interorbital width 5.5; length of nasals 13.7; width of rostrum at level of antorbital foramen 4.5.

REMARKS: The specimens from Chak Chak and the type agree in detail. The color is somewhat darker than in *kordofanensis* and is more uniform or continuous, whereas in the latter the dorsal surface appears somewhat speckled or spotted. The skull in *centralis* is larger, the anterior palatine foramina are smaller, the auditory bullae are smaller, the zygomatic arches are more flaring posteriorly, and the upper cheekteeth are smaller.

Intergradation in color, size of upper cheekteeth, and the size of the anterior palatine foramina is found with *A. n. jebelae* in the animals from Meridi. They are more referable, though, to *centralis*.

*Arricanthis niloticus jebelae* Heller

FIGURE 6,b

*Arricanthis niloticus jebelae* Heller, Smithsonian Misc. Coll., vol. 56, No. 17, p. 9, February 28, 1911. (Rhino Camp, Lado Enclave.)

SPECIMENS EXAMINED: Seventy-seven, from: Nimule, 8 (MCZ); Torit, 29 (6, MCZ); Juba, 1; Obbo, 5; Ikoto, 9; Murukurun, 50 miles east of Torit, 4 (MCZ); Bor, 2 (BM); *Malek*, 11 (BM); Mongalla, 4 (BM); Kit River, 3 (BM); Uma River, 1 (BM).

MEASUREMENTS: Averages and extremes of three adult males and three adult females from Torit are, respectively, as follows: Length



of head and body 157 (150–169), 149 (140–156); length of tail 142 (131–152); 118 (112–129); length of hind foot 31 (30–32), 30 (30); length of ear 17 (14–19), 19 (17–21); greatest length of skull 35.2 (34.2–36.0), 34.0 (32.4–34.8); condyloincisive length 33.8 (33.1–34.3), 32.3 (31.1–33.0); length of anterior palatine foramina 7.6 (7.2–7.8), 7.4 (7.1–7.7); crown length of upper toothrow 6.4 (6.3–6.6), 6.5 (6.4–6.6); greatest width across zygomatic arches 18.8 (18.7–19.0), 17.8 (17.4–18.1); least interorbital width 5.0 (4.9–5.3), 5.1 (4.9–5.3); length of nasals 13.1 (12.7–13.6), 12.7 (12.4–13.2); width of rostrum at level of antorbital foramen 4.3 (4.1–4.5), 4.3 (4.3).

REMARKS: All of the above specimens differ from *A. n. luctuosus* in generally lighter color, smaller body size, and generally shorter tail. The skulls differ in being longer and narrower, the auditory bullae generally smaller, the anterior palatine foramina shorter, the upper cheekteeth generally smaller, and the rostrum generally heavier in appearance but not wider in actual measurement.

***Arvicanthus niloticus kordofanensis* Wettstein**

FIGURE 6,b

*Arvicanthus testicularis kordofanensis* Wettstein, Anz. K. Akad. Wiss. Wien, Math.-Nat., vol. 53, p. 161, 1916. (Kadugli, southern Kordofan.)

SPECIMENS EXAMINED: Twenty, all in BM, from: Talodi, 4; Nuba Mts., 2; *Um Dona*, 2; El Fasher, 9; *Koshek*, 1; Lake No, 2.

MEASUREMENTS: The averages and extremes for three adult females from Talodi are as follows: Length of head and body 149.1 (144–156); length of tail 125 (115–130); length of hind foot 30 (30); length of ear 16.3 (16–17); greatest length of skull 33.9 (33.8–34.0); condyloincisive length 32.7 (32.2–33.2); length of anterior palatine foramina 7.5 (7.0–8.0); crown length of upper toothrow 6.9 (6.8–7.1); greatest width across zygomatic arches 16.9 (16.7–17.2); least interorbital width 5.5 (5.4–5.6); length of nasals 12.4 (12.4); width of rostrum at level of antorbital foramen 4.3 (4.3).

REMARKS: The four specimens from Talodi may be assumed to be virtual topotypes of this subspecies described from Kadugli.

*A. n. kordofanensis* differs from *A. n. testicularis* in generally darker color and in the somewhat darker hands, feet, and tail. The amount of buffy coloration on the nose and around the eyes is reduced. The belly color is buffy white with considerable admixture of blackish hairs. The skull is smaller and more delicate than in *testicularis*, the bullae are less inflated, and the anterior palatine foramina are less flaring.

The two specimens from Lake No do not agree in pelage color with any of the other specimens referable to *kordofanensis*. The skulls,

however, fall within the range of variation as noticed for this subspecies.

*Arricanthis niloticus luctuosus* Dollman

FIGURE 6,b

*Arricanthis luctuosus* Dollman, Ann. Mag. Nat. Hist., ser. 8, vol. 8, p. 339, September 1911. (Kaka, north of Fashoda.)

SPECIMENS EXAMINED: Six, all in BM, from: 20 miles north of Fashoda, 1; Kaka, 2; *Gerazi*, 3.

MEASUREMENTS: Two adult males from Kaka measure, respectively, as follows: Length of head and body 185, 184; length of tail 143, 141; length of hind foot 33, 31; length of ear 17, 17; greatest length of skull 35.5, 35.8; condyloincisive length 33.7, 34.5; length of anterior palatine foramina 8.1, 7.5; crown length of upper toothrow 7.0, 6.6; greatest width across zygomatic arches 17.3, 17.6; least interorbital width 5.2, 4.9; length of nasals 13.0, 13.4; width of rostrum at level of antorbital foramen 4.3, 4.3.

REMARKS: When specimens of *luctuosus* are compared to specimens of *A. n. testicularis* they are found to be somewhat larger and darker in color. The skull is longer, narrower, with smaller auditory bullae, and with somewhat smaller cheekteeth.

*Arricanthis niloticus testicularis* (Sundevall)

FIGURE 6,b

*Isomys testicularis* Sundevall, Kongl. Svenska Vet.-Akad. Handl., Stockholm, p. 221, 1843. (Bahr-el-Abiad.)

SPECIMENS EXAMINED: Forty-nine, all in BM, from: Sennaar, 2; Kamisa, Dinder River, 5; Gedaref, 1; El Kowa, 2; Gallabat, 9; *Hosh*, *Blue Nile*, 2; Khartoum, 13; *Ed Dueim*, 2; *Kabushiya*, 1; Shereik, 4; *Nuri*, *Merowe District*, 2; *Soba*, 1; Shendy, 4; *Letti Basin*, 1.

MEASUREMENTS: An adult male and an adult female from Kamisa, Dinder River, respectively measure as follows: Length of head and body 163, 152; length of tail 143, 146; length of hind foot 31, 31; length of ear 17, 18; greatest length of skull 38.5, 37.6; condyloincisive length 35.6, 35.3; length of anterior palatine foramina 7.8, 7.8; crown length of upper toothrow 6.8, 6.7; greatest width across zygomatic arches 20.0, 18.2; least interorbital width 6.3, 6.1; length of nasals 15.1, 14.9; width of rostrum at level of antorbital foramen 5.1, 4.9.

REMARKS: The two specimens from Sennaar may be accepted as topotypical. Both specimens are quite faded in color but the skull of the only adult agrees well with the specimens referred to above.

The color in a recently taken specimen from Kamisa is rather light above and gradually shading over the sides into the plumbeous based whitish hairs of the belly. The blackish tips of the hairs is most intense over the shoulders and diminishes in amount over the rump and on the upper legs. The nose and a ring around the eye are of pure color near Cinnamon Buff. The skull, which is of an adult male, is quite long with heavy supraorbital ridges and heavy zygomata. The rostrum is short and wide and the teeth are relatively massive. The auditory bullae are small but well inflated.

The specimens from Khartoum are somewhat paler than the animals from farther east.

*Lemniscomys barbarus zebra* (Heuglin)

FIGURE 6,c

*Mus zebra* Heuglin, Nova Acta Acad. Caes. Leop.-Carol., Halle, vol. 31, No. 7, p. 10, 1864. (Djur and Bongo, Anglo-Egyptian Sudan.)

SPECIMENS EXAMINED: Thirty-four, from: Torit, 17; Ikoto, 1; Nimule, 2; Malek, 8 (BM); 25 miles east of Lake No, 1 (BM); *Bahr-el-Ghazal*, 1 (BM); Badigeru Swamp, 20 miles east of Mongalla, 1 (BM); Fashoda, 1 (BM); *Dud Majok*, 1 (BM); Wau, 1 (BM).

MEASUREMENTS: Averages and extremes of three adult males and three adult females from Torit are, respectively, as follows: Length of head and body 102 (94–110), 101 (98–104); length of tail 112 (104–120), 110 (107–116); length of hind foot 24.5 (24–25), 25 (25); length of ear 14 (14), 15 (14.5–15.5); greatest length of skull 28.0 (27.1–28.5), 27.7 (27.0–28.3); condyloincisive length 24.9 (23.9–25.6), 24.6 (24.0–25.4); length of auditory bullae 5.4 (5.0–5.6), 5.4 (5.2–5.6); crown length of upper toothrow 4.9 (4.9–5.0), 4.8 (4.8–4.9); least interorbital width 4.5 (4.5), 4.5 (4.4–4.6); width of rostrum at level of antorbital foramen 3.6 (3.5–3.8), 3.5 (3.4–3.7); length of nasals 10.2 (9.8–10.6), 10.2 (9.8–10.5); greatest width across zygomatic arches 12.9 (12.6–13.2), 13.1 (12.5–13.5).

REMARKS: There is an apparent sexual difference in size of body, length of tail, length of hind foot, and some cranial characters in which the females generally average slightly larger than the males. In general, the color is quite uniform. Three of the specimens from Torit are only slightly paler than is the rest of the series, and the single specimen from Wau is of the same color as the majority of the specimens from Torit.

This subspecies of striped mouse seems to have the largest geographic range of any of the rodents found in the Sudan. The explanation for

this apparent lack of differentiation must await further specimens from intermediate localities or until a revision is done on the genus as a whole.

*Lemniscomys dunni dunni* (Thomas)

FIGURE 6,c

*Arvicanthis dunni* Thomas, Proc. Zool. Soc. London, p. 297, Aug. 6, 1903. (Kaga Hills, western Kordofan.)

SPECIMENS EXAMINED: Eleven, all in BM, from: Umm Keddada, 3; El Fasher, 2; *Juga Juga*, 15 miles east-northeast of El Fasher, 1; 76 miles east of El Fasher, 1; 110 miles east of El Fasher, 1; Kurra, Jebel Marra, 3.

MEASUREMENTS: An adult female from *Juga Juga* and an adult male from 76 miles east of El Fasher measure, respectively, as follows: Length of head and body 116, 108; length of tail 142, 130; length of hind foot 27, 25; length of ear 15, 16; greatest length of skull 30.1, 30.1; condyloincisive length 26.9, 26.7; length of auditory bullae 5.7, 6.2; crown length of upper toothrow 5.0, 5.3; least interorbital width 4.5, 4.8; breadth of rostrum at level of antorbital foramen 3.7, 3.4; length of nasals 11.7, 11.8.

REMARKS: The species *dunni* differs from *L. barbarus* in markedly lighter color, shorter anterior palatine foramina, markedly different shape of the posterior choanae, and the general structure of the pterygoid region. The auditory bullae are smaller, the toothrow somewhat longer, anterior parts of the zygomatic arches tapering into skull instead of flaring outward, and the braincase is more extended posterior to the posterior root of the zygoma.

There are three specimens in the British Museum without skulls from Kurra, Jebel Marra, that either represent a new species or are hybrids between *L. dunni* and *L. lynesi*. From the appearance of the skins they are intermediate in all details. I feel it best to record these specimens and only refer them to *L. dunni* provisionally.

*Lemniscomys dunni nubalis* Thomas and Hinton

FIGURE 6,c

*Lemniscomys dunni nubalis* Thomas and Hinton, Proc. Zool. Soc. London, p. 263, July 6, 1923. (Talodi, Nuba Country, southern Kordofan.)

SPECIMENS EXAMINED: Six, all in BM, from: Talodi, 2; Nuba Mountains, 1; Delami, 1; Agur, 2.

MEASUREMENTS: An adult male from the Nuba Mountains and an adult female from Talodi measure, respectively, as follows: Length of head and body 95, 90; length of tail 115, 112; length of hind foot 23, 22; length of ear 13, 13; greatest length of skull 28.4, ?; condyloincisive

length 25.5, ?; length of upper toothrow 4.9, 4.9; least interorbital width 4.3, 4.3; breadth of rostrum at level of antorbital foramen 3.3, 3.3; length of nasals 10.4, 9.1.

REMARKS: *L. d. nubalis* is somewhat smaller than the nominate race and is pronouncedly brighter in color. The color of *dunni* is a pale buff while *nubalis* is a bright golden color. The sides and flanks, instead of being white as in *dunni*, are washed with the golden ochraceous color of the dorsum.

*Lemniscomys lynesi* Thomas and Hinton

*Lemniscomys lynesi* Thomas and Hinton, Proc. Zool. Soc. London, p. 267, July 6, 1923. (Central Jebel Marra, Darfur.)

SPECIMENS EXAMINED: Ten, all in BM, from: *Jebel Marra*, 3; Central Jebel Marra, 6; *South Downs*, *Jebel Marra*, 1.

MEASUREMENTS: An adult female from South Downs, Jebel Marra, measures as follows: Length of head and body 101; length of tail 104; length of hind foot 23; length of ear 14; condyloincisive length of skull 23.9; crown length of upper toothrow 5.1; least interorbital width 4.5; breadth of rostrum at level of antorbital foramen 3.6.

REMARKS: In the original description of this species, Thomas and Hinton suggested that it was more nearly related to *L. zebra* (= *L. barbarus zebra*) than to any other group in the genus. In all cranial details, and, most strikingly, in the distribution of the dorsal lines and spots and in degree of spininess, *L. lynesi* is most closely allied to *L. striatus*. From all characters studied it appears as though this is not a valid species but merely a subspecies of *striatus*. I feel certain that intergradation could be demonstrated if specimens were obtained from intermediate localities. However, until such time as specimens showing intergradation are obtained I prefer to let the name stand as a full species.

The skull, as well as the skin, is markedly different from *dunni*. The color is the darkest of any of the kinds in the Sudan. The skull differs from that of *dunni* in the markedly different shape of the bullae, in the length of the anterior palatine foramina, and in the very different structure of the pterygoid region.

*Lemniscomys macculus macculus* (Thomas and Wroughton)

*Arvicanthis macculus* Thomas and Wroughton, Trans. Zool. Soc. London, vol. 19, p. 515, March 1910. (Mokia, southeastern Ruwenzori, Uganda.)

SPECIMENS EXAMINED: Three, from: Torit, 1; Nimule, 2.

MEASUREMENTS: The measurements of an adult male from Nimule, are as follows: Length of head and body 96; length of tail 121; length of hind foot 25; length of ear 16; greatest length of skull 26.2; condy-

loincisive length 24.2; length of auditory bullae 5.2; crown length of upper toothrow 4.8; least interorbital width 4.5; breadth of rostrum at level of antorbital foramen 3.3; length of nasals 10.2.

REMARKS: In *L. macculus* the proportion of the least interorbital width to the width of the rostrum ranges from 71.2 to 73.3 percent (79.7 to 81.6 percent in *striatus*) and the proportion of the length of the nasals to the total length of the skull ranges from 37.8 to 38.9 percent (36.0 to 36.7 percent in *striatus*). It may be noted that in the first proportion the size difference between *L. macculus* and *L. striatus* is apparent, but in the second proportion, that of nasals to total length of skull, the ratio is reversed, which shows that the nasals, even though measuring shorter in *macculus*, occupy more of the total length of the skull than in *striatus*.

These two proportions appear to hold good on other specimens of these two species in both the U. S. National Museum and the British Museum collections so that they perhaps will be valid for critically distinguishing the two species where they occur together.

In general, *macculus* is a smaller animal than is *striatus*. In the former the hind foot usually measures less than 26 mm., while in the latter the hind foot is usually larger.

*Lemniscomys striatus massaicus* (Pagenstecher)

*Mus* (*Lemniscomys*) *barbarus* L. var. *Massaicus* Pagenstecher, Jahrb. Hamburgischen Wiss. Anst., vol. 2, p. 45, 1885. (Lake Naivasha.)

SPECIMENS EXAMINED: Thirty, from: Gilo, Imatong Mountains, 11 (4, MCZ); Torit, 2; Nimule, 5 (3, MCZ); *Katire*, 9 (MCZ); Magwe, 2 (MCZ); *Talanga Forest, Imatong Mountains*, 1 (MCZ).

MEASUREMENTS: An adult male and an adult female from Gilo, Imatong Mountains, respectively measure as follows: Length of head and body 123, 107; length of tail 130, 130; length of hind foot 28, ?; length of ear 11, 12; greatest length of skull 29.4, 29.0; condyloincisive length 26.5, 26.2; length of auditory bullae 5.9, 5.0; crown length of upper toothrow 4.9, 5.1; least interorbital breadth, 4.8, 5.0; breadth of rostrum at level of antorbital foramen 3.5, 3.8; length of nasals 10.6, 10.8.

REMARKS: This species can easily be confused with *L. macculus*. There are, however, several pronounced cranial differences between the two species. In the present series, the proportion of the least interorbital width to the width of the rostrum is greater; and the proportion of the length of the nasals to the total length of the skull is less in the larger species *striatus*.

In *striatus*, the anterior palatine foramina are nearly parallel-sided as opposed to constricted anteriorly in *macculus*. The upper tooth-row, the least interorbital breadth, the breadth of the rostrum, and the condyloincisive length are all noticeably larger in *striatus* than in *macculus*.

### Remarks on *Rattus*-like genera

In attempting to identify the various species of rattoid animals found in the Sudan, extreme confusion was apparent. Without a complete revision of the "genera" entailed in this group, the following remarks are of necessity limited in their application. It is apparent, however, that so far as the kinds found in the Sudan are concerned these differences and similarities do apply.

It is apparent to me that Ellerman and his co-authors have gone to an extreme in what they classify under the genus *Rattus*. Certainly there appears to be a superfluity of generic names applied to the *Rattus*-like rats in central Africa. Among these I am primarily concerned with *Aethomys*, *Mastomys*, *Praomys*, *Hylomyscus*, and *Myomys*. Ellerman, Morrison-Scott, and Hayman (1953) consider these genera to be, at best, subgenera of the genus *Rattus*, and they consider the name *Myomys* to have no status since the type species is not certainly identifiable. For the Anglo-Egyptian Sudan, *Aethomys*, *Mastomys*, and *Praomys* are distinguishable from typical *Rattus rattus* at both the generic and specific levels. The genus *Praomys* as here understood contains the names previously referred to *Myomys* and *Hylomyscus*. I can find no means by which either of the above genera can be distinguished from *Praomys* even at the subgeneric level, but the species can be distinguished without question. It is true that this particular complex is in dire need of a revision which is not based on a single character only.

The significance of the mammary formula is at the present of no importance in determining generic rank among these animals since males, and females taken other than in the breeding season, do not show the mammae at all. Table 1 is based on cranial characters that are consistent in the specimens and species examined from the Sudan and which I feel are of sufficient importance to warrant retaining these names as full genera. This has been an extremely difficult assemblage to classify, but the characters of the table do separate the genera occurring together. It is apparent that Ellerman and his co-authors, in lumping so many genera and species, are either unaware of or have ignored the matter of convergence in these particular animals.

TABLE 1.—*Consistent cranial characters in specimens and species examined from the Sudan*

Character	<i>Rattus</i>	<i>Mastomys</i>	<i>Aethomys</i>	<i>Praomys</i>
*T1 of M <sup>2</sup> .....	Large and not in line with second lamina.	Large and more or less in line with second lamina.		Small but pronounced and markedly anterior to second lamina, as in <i>Rattus</i> .
T3 of M <sup>2</sup> .....	Absent.	Present but reduced and more or less in line with T1 and T5.		Present, peg-like and in line with T1.
Anterior palatine foramina.	Extend posterior to anterior root of M <sup>1</sup> .	Extend to middle of M <sup>1</sup> .	Extend to base of M <sup>1</sup> and never beyond one-third of the length of the tooth.	
Lateral margins of wings of pterygoid.	Concave.	Straight.		Convex.
Anterior margin of zygomatic plate.	Straight, vertical, slightly rounded on dorsal edge.	Straight, not vertical, and strongly rounded on dorsal edge.	Concave, not vertical, and not strongly rounded.	Straight, vertical and not strongly rounded.
Antorbital foramina.	Large and triangular.	Large and rounded.		Small and triangular.

\*Cusp terminology of the molars is based on Miller, Catalogue of the Mammals of Western Europe, p. 801, 1912.

*Aethomys kaiseri alghazal* (Wroughton)

FIGURE 6,*d*

*Mus alghazal* Wroughton, Ann. Mag. Nat. Hist., ser. 7, vol. 20, p. 501, December 1907. (Chak Chak, Bahr-el-Ghazel.)

SPECIMENS EXAMINED: Five, all in BM, from: Tembura, 1; *Deim Zubeir*, 1; Wau, 1; Khor, half-way between Chak Chak and Deim Zubeir, 1; Chak Chak, 1.

MEASUREMENTS: The measurements of an adult male from Chak Chak are as follows: Length of head and body 194; length of tail 195; length of ear 16; greatest length of skull 35.7; condyloincisive length 32.9; least interorbital width 5.6; length of nasals 13.6; width of rostrum at level of antorbital foramen 4.6; greatest width across zygomatic arches 17.0; crown length of upper toothrow 6.3; length of anterior palatine foramina 8.0.

REMARKS: This subspecies is decidedly paler in color than are specimens of *A. k. helleri* from Rhino Camp or from the eastern part of Equatoria Province. This paler color is caused by less gray (or black-tipped hairs) and more light brown being visible in the pelage. The underparts are strongly washed with buffy. In all specimens the feet are white above. The tails are nearly naked and average about 10 scale rows per centimeter.



*Aethomys kaiseri helleri* (Hollister)FIGURE 6,*d*

*Epimys kaiseri centralis* Hollister, Smithsonian Misc. Coll., vol. 63, No. 7, p. 10, June 1914. (Rhino Camp.)

*Rattus helleri* Hollister, Proc. Biol. Soc. Washington, vol. 31, p. 97, June 29, 1918. (New name to replace *E. k. centralis*, preoccupied by *Mus auricomis centralis* Schwann, 1906.)

SPECIMENS EXAMINED: Twenty, from: Moli, 35 miles north of Nimule, 3 (MCZ); Nimule, 5 (4, MCZ); *Magwe*, 36 miles southwest of Torit, 2 (MCZ); Katire, 1 (MCZ); Torit, 5 (1, MCZ); Juba, 1; *Nadiopgi*, 2; *Lokwi*, 25 miles south of Torit, 1.

MEASUREMENTS: An adult male and an adult female from Torit measure, respectively, as follows: Length of head and body 163, 165; length of tail 135, 150; length of hind foot 30, 32; length of ear 14, 18; greatest length of skull 39.7, 40.3; condyloincisive length 36.8, 36.7; length of nasals 16.2, 17.2; least interorbital width 5.9, 5.8; width of rostrum at level of antorbital foramen 5.2, 5.1; greatest width across zygomatic arches 19.4, 18.8; crown length of upper toothrow 5.9, 6.1; length of anterior palatine foramina 8.8, 9.3.

REMARKS: In general these animals are quite variable in any one given character. This is especially so in the size of the upper molars, but even in this character these specimens are consistently larger than in the type of *A. k. helleri*. There are, however, some specimens in the type series of *helleri* that have the molars as large as and even somewhat larger than any in the present material.

There are other characters of the pelage color and cranium that are divergent from the type and type series of *helleri*. These divergences, though, are of such minute amount that it is not deemed advisable to erect a separate name for this population. It seems as though here is an example where subspeciation is occurring but that the characters have not become stable enough to warrant complete recognition.

*Mastomys kulmei*, new speciesFIGURE 6,*d*

TYPE: BM No. 23.1.1.403, adult male, skin and skull, from Kulme, Wadi Aribo, 3,300 feet, Darfur Province, Anglo-Egyptian Sudan. Obtained September 15, 1921, by Lynes and Lowe, original No. 912.

SPECIMENS EXAMINED: Eighty-two, all in BM, from: Kulme, Wadi Aribo, 28; Niurmya, 5; 6 miles west of El Fasher, 1; 52 miles west-southwest of El Fasher, 2; 35 miles west-southwest of El Fasher, 2;

*Kurra, Jebel Marra, 10; Jebel Marra, 7; Zalingei, 8; southern foothills, Jebel Marra, 19.*

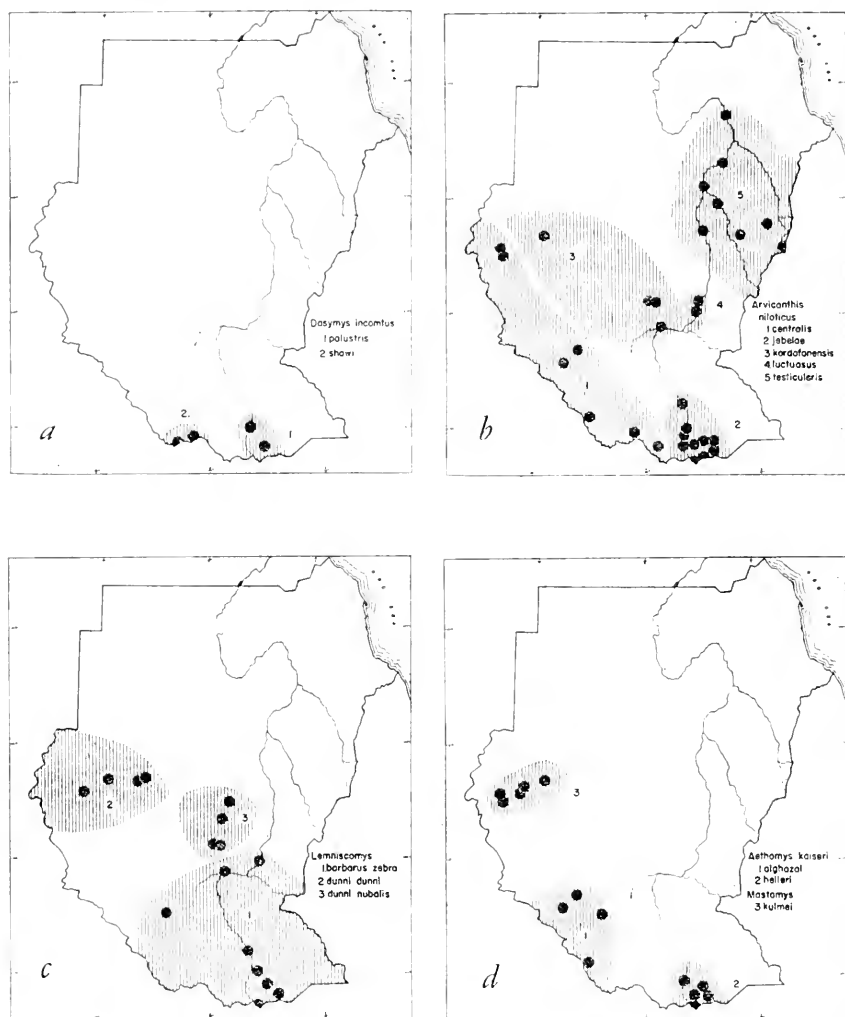


FIGURE 6.—Distribution of *Dasyms*, *Arvicanthis*, *Lemniscomys*, *Aethomys*, and *Mastomys* (in part) in the Anglo-Egyptian Sudan. (Scale: 1 inch=400 miles.)

DIAGNOSIS: Upperparts Tawny-Olive, color purest on cheeks, shoulders, and top of head. All hairs plumbeous at base, the pigmented portion only 1 to 2 mm. in length and then finely tipped with black; hands, feet, and entire underparts white. The underparts but lightly washed with buff. Tail light colored and of the same color

density top and bottom. Upperparts not delineated from white of belly by a line of pure color. Skull relatively small, anterior palatine foramina short, upper molars small, pterygoid region nearly triangular in form, zygomatic arches bowed downwards but not laterally, auditory bullae relatively small, rostrum relatively long and narrow, and supraorbital bead moderately developed and passing caudad into lateral ridges on skull.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 120; length of tail 124; length of hind foot (s. u.) 22, dry c. u. 24; length of ear 20; greatest length of skull 31.2; condyloincisive length 29.2; length of anterior palatine foramina 6.8; crown length of upper toothrow 4.3; least interorbital width 4.4; width of rostrum at level of antorbital foramen 3.9; length of nasals 12.2; greatest width across zygomatic arches 15.1.

COMPARISONS: From the type of *Mastomys coucha* (= *natalensis*), *M. kulmei* differs in lighter, brighter color, somewhat longer hind feet, longer tail, and longer ears. The skull differs in that the anterior palatine foramina are shorter, the molars smaller, the pterygoid region not flaring laterally but the pterygoid wings being carried nearly straight back and the fossae being shallow instead of deeply excavated, and rostrum longer and slenderer.

From the type of *M. n. ugandae*, which is an immature male, *M. kulmei* differs in smaller size, lighter and brighter color, and, in animals of comparable age, a markedly smaller skull in all respects. The teeth are smaller and the pterygoid region differs as described for *M. coucha*.

From the type of *M. n. blainei*, *M. kulmei* differs in lighter, brighter color and longer tail. The skull differs in generally smaller size, shorter anterior palatine foramina, pterygoid region as described for *M. coucha*, and a longer, narrower rostrum.

From *M. n. macrolepis*, as known from El Kowa, *M. kulmei* differs in smaller size and lighter, brighter color. The skull is in all respects smaller and far more delicate, with relatively as well as actually larger auditory bullae.

REMARKS: *Mastomys kulmei* occurs with another member of the genus in most of its range. They may be distinguished from one another by the generally darker color of the *coucha* kinds and by the skulls, which may be separated by the characters as set forth under comparisons.

Thomas and Hinton (1923, p. 266) remarked that there appeared to be two kinds of *Mastomys* in the Lynes-Lowe collection but postponed any naming of these kinds, merely referring them to the earlier known *M. macrolepis* and *M. ugandae* group.

*Mastomys natalensis agurensis*, new subspecies

## FIGURE 7,a

TYPE: BM No. 28.3.11.54, adult male, skin and skull, from Agur, Nuba Mountain Province, Anglo-Egyptian Sudan. Obtained March 8, 1927, by W. Rutledge.

SPECIMENS EXAMINED: Twelve, all in BM, from: Agur, 2; *Jebel Um Dona*, 1; Delami, 1; Talodi, 2; *Abu Heraz*, 1; Nahud, 1; Dilling, 2; Nuba Mountains, 2.

DIAGNOSIS: Upperparts near Buckthorn Brown but slightly intermixed with black. Color purest on upper arms, shoulders, and cheeks. Underparts, thighs on inner surfaces, forearm on inner surface, hands, and feet white. Skull relatively large, auditory bullae relatively small, zygomatic arches not widely flaring, dorsal surface rather strongly arched.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 114; length of tail 126; length of hind foot 23; length of ear 18; greatest length of skull 31.8; condyloincisive length 29.9; length of anterior palatine foramina 7.5; crown length of upper toothrow 4.6; least interorbital width 4.4; width of rostrum at level of antorbital foramen 4.1; length of nasals 12.6; greatest width across zygomatic arches 15.0.

COMPARISONS: From *M. n. blainei*, *M. n. agurensis* differs in markedly lighter color, longer tail, and shorter hind foot. The skulls differ in that the zygomata are narrower, auditory bullae smaller, dorsum of skull decidedly more arched, rostrum heavier, and braincase smaller.

From *M. n. macrolepis*, *M. n. agurensis* differs in being smaller and lighter in color. The skull is smaller and of less robust build.

Compared with *M. n. ismailiae*, *M. n. agurensis* is lighter in color and smaller in all external measurements. The skull is smaller in all measurements.

From *M. n. marrensis*, *M. n. agurensis* differs in markedly lighter color and somewhat smaller size. The skull is smaller, the auditory bullae are smaller, and the dorsal surface is somewhat more arched.

REMARKS: The specimen from Abu Heraz is somewhat darker in color than typical *agurensis* and may represent an intergrade with *blainei*, but since the specimen is so immature it is not possible to be positive.

The mammals available from the Nuba Mountain region all present minor differences from surrounding named kinds. It is very possible that, if additional collecting were to be done in this area, an area of endemism would be found similar to that of the Jebel Marra.

*Mastomys natalensis blainei* (Wroughton)

FIGURE 7,a

*Mus blainei* Wroughton, Ann. Mag. Nat. Hist., ser. 7, vol. 20, p. 502, December 1907. (Chak Chak, Bahr-el-Ghazal.)

**SPECIMENS EXAMINED:** Twenty-three, all in BM, from: Moyen, 1; Wau, 8; Tembura, 5; Katta, 1; Chak Chak, 8.

**MEASUREMENTS:** An adult male from Chak Chak measures as follows: Length of head and body 125; length of tail 115; length of hind foot 25; length of ear 17; length of anterior palatine foramina 7.5; crown length of upper toothrow 4.6; least interorbital width 4.5; width of rostrum at level of antorbital foramen 3.8; length of nasals 12.1; greatest width across zygomatic arches 15.3.

**REMARKS:** *M. n. blainei* is generally darker in color than any of the surrounding kinds with the exception of *M. n. macrolepis*. It may be distinguished from the latter by its much narrower zygomatic arches and narrower rostrum. From the other subspecies adjacent to *blainei* it may be distinguished cranially by its narrower rostrum and generally wider zygomatic arches.

*Mastomys natalensis ismailiae* (Heller)

FIGURE 7,a

*Epimys concha* (sic) *ismailiae* Heller, Smithsonian Misc. Coll., vol. 63, No. 7, p. 9, June 24, 1914. (Gondokoro.)

**SPECIMENS EXAMINED:** One hundred and thirteen, from: Obbo, 23; Torit, 27 (4, MCZ); Juba, 6 (2, BM); Nimule, 10 (1, MCZ); Lotti Forest, 1; Magwe, 36 miles southwest of Torit, 2 (MCZ); Mongalla, 10 (BM); Malek, 7 (BM); Bor, 5 (BM); Duk, 2 (BM); Evos, Didinga Mountains, 1 (BM); Towat Boma, 2 (BM); Kagula, 6 (BM); Lake No, 2 (BM); Gondokoro, 1 (BM); no locality, 1; Kaka, 3 (BM); Fashoda, 4 (BM).

**MEASUREMENTS:** An adult male and an adult female from Juba measure, respectively, as follows: Length of head and body 143, 143; length of tail 127, 128; length of hind foot 28, 27; length of ear 16, 16; greatest length of skull 32.9, ?; condyloincisive length 31.1, 31.5; greatest width across zygomatic arches 15.7, 16.2; least interorbital width 5.0, 4.6; length of nasals 13.8, 13.2; crown length of upper toothrow 4.9, 5.2; length of anterior palatine foramina 8.1, 7.8.

**REMARKS:** In spite of the large number of specimens of this subspecies available for study, only a few were fully adult. Of those that were adult, few had complete crania which could be measured.

The specimens from Juba are near topotypes of *ismailiae* and are fully adult, showing considerable wear on the molars. None of the specimens in the type series of *ismailiae* are fully adult, yet the reddish coloration as given by Heller as characteristic appears to be the only feature distinguishing this race from *ugandae* as known by specimens from Kampala, Uganda. Color, however, appears to be extremely variable since the adult specimens from Torit range from bright reddish to brownish. The skulls, though, show no marked variation in configuration or measurements from the type of *ismailiae*. Two specimens from Obbo approach *ugandae* in the saturate coloration which appears to be typical of that race. It is apparent that in this group of specimens the only ones which are truly typical of *ismailiae* are the ones from Juba. The others, at least so far as color is concerned, are apparently intergrades with *ugandae* but more referable in cranial characters to *ismailiae*.

At best, the material available can be distinguished only when adults are compared. Immatures from Nimule and Obbo show the intense reddish coloration typical of the type of *ismailiae* and have a white belly. In *ugandae*, the coloration of the belly is a strong suffusion of buff which is shown in a few specimens from Obbo.

*Mustomys natalensis macrolepis* (Sundevall)

FIGURE 7,a

*Mus macrolepis* Sundevall, Kongl. Svenska Vet.-Akad. Handl., Stockholm (1842), p. 218, 1843. (Sennaar.)

SPECIMENS EXAMINED: All in BM, from: Ducim, 1; Kamisa, Dinder River, 1; Roseires, 1; El Kowa, 1; Gedaref, 1.

MEASUREMENTS: An adult female from El Kowa measures as follows: Length of head and body 142; length of tail 151; length of hind foot 24; length of ear 20; total length of skull 34.3; condyloincisive length 32.3; length of anterior palatine foramina 7.9; crown length of upper toothrow 4.9; least interorbital width 4.6; width of rostrum at level of antorbital foramen 4.3; length of nasals 14.2; greatest width across zygomatic arches 17.3.

REMARKS: *M. n. macrolepis* may be distinguished from surrounding races of *M. natalensis* by its generally darker color and somewhat larger size. It is noticeably different cranially in that the auditory bullae are markedly smaller and less inflated.

*Mustomys natalensis marrensis*, new subspecies

FIGURE 7,a

TYPE: BM No. 23.1.1.425, adult female, skin and skull, from Kulme, Wadi Aribo, Darfur Province, Anglo-Egyptian Sudan. Obtained August 28, 1921, by Lynes and Lowe, original No. 897.

SPECIMENS EXAMINED: Nineteen, all in BM, from: Kulme, Wadi Aribo, 14; *Niurmya*, 1; *Kurra*, *Jebel Marra*, 3; *Jebel Marra*, 1.

DIAGNOSIS: Upperparts, in general tone, near Saccardo's Umber. The pure color band of the hairs are near Sayal Brown but because of the intense admixture of black the darker color is apparent. Underparts plumbeous, but lightly tipped with buffy white. Hands and feet white, tail dark, nearly naked, and of uniform color above and below. Skull relatively large and robust; anterior palatine foramina long; upper toothrow relatively heavy; auditory bullae moderately well developed; rostrum, in general, heavy; zygomatic arches nearly parallel-sided, not tending to bow laterad excessively.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 145; length of tail 127; length of hind foot 28; length of ear 18; greatest length of skull 32.7; condyloincisive length 30.9; length of anterior palatine foramina 7.6; crown length of upper toothrow 4.8; least interorbital width 4.2; width of rostrum 4.1; length of nasals 14.1; greatest width across zygomatic arches 16.0.

COMPARISONS: *M. n. marrensis* differs from *M. n. ugandae* in slightly paler color both above and below, the buffy wash of the belly being somewhat more pronounced. The skull is somewhat longer and more slender; the zygomata not flaring so much; auditory bullae smaller; rostrum longer and narrower; pterygoid region shorter anteroposteriorly.

From *M. n. blainei*, *M. n. marrensis* differs in darker color, longer hind foot, and longer tail. The skull is larger in all respects, with the exception that the zygomatic arches are narrower.

From *M. n. macrolepis*, *M. n. marrensis* is of about the same color but somewhat lighter and smaller in size. The skull is smaller in all respects. The bullae are relatively as well as actually more inflated, the rostrum is narrower, the pterygoid region is shorter, and the zygomata are less flaring.

From *M. kulmei*, *M. n. marrensis* is darker, larger in all respects, and shows the same variation in cranial characters as do the other members of the species *natalensis*.

REMARKS: Two species of *Mastomys* occur together at Kulme, Wadi Aribo. One, *M. n. marrensis* is dark and large and is decidedly of the *natalensis* group, the other, *M. kulmei*, is relatively small and in no way resembles any member of the *natalensis* complex.

Thomas and Hinton (1923, p. 266) referred *kulmei* to the "wild living" kind *macrolepis*, and *marrensis* to the "house living" kind *ugandae*. It has since been shown that commensalism does not seem to affect the color of these animals and that animals of the same color

are taken both commensally and ferally. It may be that there is a habitat difference for these two kinds of *Mastomys* at Kulme, but if so the collectors failed to note it.

*Mastomys natalensis ugandae* (De Winton)

FIGURE 7,a

*Mus ugandae* De Winton, Ann. Mag. Nat. Hist., ser. 6, vol. 20, p. 317, September 1897. (Entebbe, Uganda.)

SPECIMENS EXAMINED: Five, all in BM, from: Ukanda, Bahr-el-Ghazal, 1; Meridi, 2; Yei, 2.

MEASUREMENTS: An adult, unsexed, from Yei has no external measurements, but the skull measures as follows: Greatest length 33.0; condyloincisive length 31.0; length of anterior palatine foramina 8.2; crown length of upper toothrow 5.0; least interorbital width 4.7; width of rostrum at level of antorbital foramen 4.1; length of nasals 13.9; greatest width across zygomatic arches 15.8.

REMARKS: Since the type specimen of *ugandae* is an immature male it is unsuitable for comparison with other types in the species. Topotypes of *ugandae* which have been available are adult and are generally darker in color than any of the adjacent kinds except *macrolepis*.

It is interesting that this subspecies appears to enter the Sudan only where the Ubangi-Uelle Savanna District of the Guinean Savanna Province extends into the Yambio District.

The skulls of *ugandae* may be distinguished from those of *macrolepis* by their smaller size and somewhat larger auditory bullae.

*Praomys albipes fuscirostris* (Wagner)

FIGURE 7,b

*Mus fuscirostris* Wagner, Arch. Naturg., vol. 11, sec. 1, p. 149, 1845. (Sennaar, Anglo-Egyptian Sudan.)

SPECIMENS EXAMINED: Two, both in BM, from: El Obeid, 1; Kordofan, 1.

MEASUREMENTS: The external measurements of an adult male from Kordofan are as follows: Length of head and body 120; length of tail 95; length of hind foot 37; length of ear 15. The cranial measurements of an adult female from El Obeid are as follows: Greatest length of skull 31.5; condyloincisive length 29.8; length of anterior palatine foramina 7.7; crown length of upper toothrow 4.7; least interorbital width 4.0; width of rostrum at level of antorbital foramen 3.9; length of nasals 12.6; greatest width across zygomatic arches 14.9.

REMARKS: These specimens are lighter in dorsal coloration than are specimens of the nominate race from Abyssinia. It seems odd that



there should be such a hiatus in distribution for this species and it may well be that the specific determination is erroneous. As pointed out elsewhere, these nomenclatorial problems can be resolved only by a competent revision.

*Praomys butleri* (Wroughton)

FIGURE 7,*b*

*Mus butleri* Wroughton, Ann. Mag. Nat. Hist., ser. 7, vol. 20, p. 503, December 1907. (Between Chak Chak and Dem Zubeir, Bahr-el-Ghazal.)

SPECIMEN EXAMINED: The type.

MEASUREMENTS: The type, an adult female, has the following measurements: Length of head of body 90; length of tail 118; length of hind foot 20; length of ear 16; greatest length of skull 26.4; condyloincisive length 24.5; length of anterior palatine foramina 6.1; crown length of upper toothrow 4.4; least interorbital width 4.1; width of rostrum at level of antorbital foramen 3.4; length of nasals 9.3.

REMARKS: The type and only known specimen is reddish brown with white underparts and white hands and feet. The hairs of the belly are white to the base. There is a faint suggestion of a dorsal area darker than the color of the sides, thus giving the animal the appearance of having a stripe down the back.

Ellerman (1941, p. 209) placed *butleri* as a full species under the subgenus *Praomys* in the genus *Rattus*. Until further information is available I feel it is best to regard this specimen as a valid species of the genus *Praomys*. Therefore, I do not follow Allen in allocating it to subspecific status under the species *denniae*, which is also referred to the genus *Praomys*.

*Praomys fumatus oweni*, new subspecies

FIGURE 7,*b*

TYPE: MCZ No. 45883, adult male, skin and skull, from Murukurun, 50 miles east of Torit, Torit District, Equatoria Province, Anglo-Egyptian Sudan. Obtained May 9, 1950, by John S. Owen, original No. 1030.

SPECIMENS EXAMINED: Eighteen, all in MCZ, from: *Lafon*, 4; Murukurun, 1; Lalanga, eastern Lofit Hills, 1; Gilo, Imatong Mountains, 1; Ikoto, 2; *Labalwa*, 4; *Loa*, 1; *Okaru*, 3; Opari, 1.

DIAGNOSIS: General over-all dorsal color near Snuff Brown; pure color on shoulders near Cinnamon-Buff; dorsal color ending abruptly on sides, cheeks, upper arm, and leg in the pure white of the belly, throat, chin, and under sides of the forelimbs and hindlimbs; all hairs of underparts white to base; dorsal surfaces of hands and feet white. Skull relatively long and narrow; anterior palatine foramina long;

upper cheekteeth relatively small; auditory bullae relatively large; wings of pterygoid not markedly flaring laterally; rostrum relatively long but broad.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 119; length of tail 126; length of hind foot 20; length of ear from notch 17; condyloincisive length of skull 26.1; greatest width across zygomatic arches 13.7; least interorbital width 4.1; length of nasals 10.6; crown length of upper toothrow 4.5; length of anterior palatine foramina 6.4; width of rostrum at level of antorbital foramen 3.7.

COMPARISONS: *Praomys fumatus oweni* differs from *P. f. subfuscus* as known by specimens from Sotik, British East Africa, as follows: Color generally darker on dorsal areas; belly with hairs pure white to base instead of plumbeous at base and belly hairs lacking the buffy wash of *subfuscus*. Skull is somewhat smaller in total length; nasals shorter; interorbital width less; rostrum shorter and narrower; and the wings of the pterygoid somewhat less flaring.

From *Praomys fumatus fumatus*, *P. f. oweni* differs as follows: Dorsal coloration generally lighter and without prominent chestnut color over nape and shoulders; underparts in both clear white; tail generally more finely annulated. Skull generally larger; anterior palatine foramina longer and narrower; wings of pterygoid not so widely flaring; rostrum somewhat longer and wider; auditory bullae slightly larger; width across zygomatic arches greater.

REMARKS: Specimens of this subspecies may be distinguished from *Praomys tullbergi* by their generally smaller size; finer annulations of the tail; and the clear white instead of slaty grey belly.

Most of the specimens listed above were taken in a rocky habitat while the others came from cultivated areas.

#### *Praomys stella kaimosae* (Heller)

*Epimys alleni kaimosae* Heller, Smithsonian Misc. Coll., vol. 59, No. 16, p. 7, July 5, 1912. (Kaimosi, Kakumega Forest, British East Africa.)

SPECIMEN EXAMINED: One from Obbo.

MEASUREMENTS: A subadult male from Obbo has the following measurements: Length of head and body 148; length of tail 136; length of hind foot 29. No cranial measurements are available.

REMARKS: The only specimen available of this small mouse is a subadult which has not yet molted into the complete adult pelage. In addition the skull is badly broken but from the characters remaining the specimen belongs to the species *P. stella*. There are some differences in color and size of bullae, but until more specimens are available from this area I feel it best to refer its subspecific status to *kaimosae*.

*Praomys tullbergi sudanensis*, new subspecies

TYPE: CNHM No. 67268, adult male, skin and skull, from Lotti Forest, Torit District, Anglo-Egyptian Sudan. Obtained April 7, 1950, by Harry Hoogstraal, original No. 5438.

SPECIMENS EXAMINED: Twenty-one, from: Gilo, Imatong Mountains, 16 (12, MCZ); Opari, 30 miles north-northeast of Nimule, 1 (MCZ); *Lotti Forest*, 2; Imowa, Didinga Mountains, 1 (BM); *Talanga Forest*, 1 (BM).

DIAGNOSIS: Upperparts near Antique Brown which terminates abruptly on the sides, flanks, and shoulders in the plumbeous-based, white-tipped hairs of the entire underparts, including the chin, throat, and undersides of forelimbs and hindlimbs. Tail longer than head and body and the hands and feet white with traces of the dorsal color extending on the proximal portions of the first metatarsals and metacarpals. Entire underparts with hairs white-tipped but plumbeous at base. Skull with but slightly developed supraorbital ridges; zygomatic arches relatively heavy; nasals short; anterior palatine foramina relatively short; braincase relatively flat; auditory bullae relatively large.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 121; length of tail 149; length of hind foot 25; length of ear 21; condyloincisive length of skull 29.2; greatest width across zygomatic arches 15.6; least interorbital width 5.0; length of nasals 11.5; crown length of upper toothrow 4.7; length of anterior palatine foramina 7.0; width of rostrum at level of antorbital foramen 3.7.

COMPARISONS: From the type and type series of *Praomys tullbergi peromyscus*, *P. t. sudanensis* differs in lighter color throughout, belly hairs without buffy wash, tail more finely annulated, anterior palatine foramina shorter, auditory bullae larger, pterygoid wings more flared laterally, nasals shorter, least interorbital width greater, and braincase flatter.

*Praomys tullbergi sudanensis* differs from *P. t. jacksoni* as known from specimens from Kaimosi, British East Africa, in generally brighter color dorsally. The skull differs in that the upper cheekteeth are smaller, auditory bullae larger, width across zygomatic arches greater, rostrum wider and shorter, anterior palatine foramina shorter, nasals shorter, and the braincase is flatter.

REMARKS: The type specimen of *P. t. jacksoni* from Entebbe, Uganda, is so young that it is worthless for comparative purposes. Therefore, the specimens referred to *jacksoni* from Kaimosi have been used instead.

The reddish brown color of these animals is characteristic of the fully adult pelage. The juveniles and subadults are a much darker plumbeous color with some admixture of brownish hairs. The change from subadult to adult pelage apparently commences on the sides and works dorsally to meet in the middorsal line. Several specimens in the above series show this transitional pelage.

*Mus bellus aequatorius* Setzer

FIGURE 7,c

*Mus bellus aequatorius* Setzer, Journ. Washington Acad. Sci., vol. 43, No. 10, p. 335, October 22, 1953. (Torit.)

SPECIMENS EXAMINED: Forty-eight, from: Torit, 43 (14, MCZ); Ikoto, 1; Obbo, 1; Loa, 1; Magwe, 1 (MCZ); Nimule, 1 (MCZ).

MEASUREMENTS: Even though a large series has been available for study, the type is the only specimen that approaches completeness in the skull. Owing to an error the external measurements as given in the original description are wrong. The correct measurements are as follows: Length of head and body 54; length of tail 37 (not 32); length of hind foot 12 (not 11); length of ear from notch 7; condyloincisive length of skull 15.9; crown length of upper toothrow 2.8; greatest width across zygomatic arches 8.8; least interorbital width 3.1; length of nasals 6.2; width of rostrum at level of antorbital foramen 2.2.

REMARKS: Specimens of this small mouse taken during the months of April through July show a marked darkening of the pelage and lack almost entirely the white postauricular and subauricular spots that are so characteristic of this subspecies in the pelage in the months from November through February. Regardless of the pelage color, this subspecies may be distinguished from the contiguous subspecies in eastern Africa by the shorter toothrow and narrower rostrum.

This mouse appears to have open savanna as its primary habitat. A few specimens, however, were taken in buildings in Torit.

*Mus bellus delamensis*, new subspecies

FIGURE 7,c

TYPE: BM No. 28.3.11.61, adult male, skin and skull, from Delami, Nuba Mountain Province, Anglo-Egyptian Sudan. Obtained June 3, 1927, by W. Ruttledge, original No. 387.

SPECIMENS EXAMINED: Eleven, all in BM, from: Delami, 9; Agur, 1; *Jebel Kadar*, 1.

DIAGNOSIS: Upperparts near Cinnamon-Buff, purest on sides, flanks, and cheeks; middorsal area strongly intermixed with black hairs, thus presenting a rather marked stripe from the nose to the

base of the tail; entire underparts, subauricular spots, and dorsal surfaces of hands and feet pure white. Skull small, upper toothrow short, auditory bullae but moderately inflated, anterior palatine foramina relatively long, rostrum relatively short and broad, interpterygoid space broadly V-shaped, interorbital region relatively wide.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 51; length of tail 36; length of hind foot 11.5; length of ear 9; greatest length of skull 16.1; condyloincisive length 14.9; length of anterior palatine foramina 3.5; crown length of upper toothrow 2.9; least interorbital width 3.1; width of rostrum at level of antorbital foramen 2.2; length of nasals 6.2; greatest width across zygomatic arches 8.5.

COMPARISONS: From *M. b. gondokorae*, *M. b. delamensis* may be distinguished by its markedly lighter color and smaller size. Skull smaller in all measurements except crown length of upper toothrow and length of nasals, anterior palatine foramina smaller, auditory bullae less inflated, and rostrum narrower.

*M. b. delamensis* may be distinguished from *M. b. enclavae* by its markedly lighter color and smaller size. The skull is markedly smaller in all dimensions but the auditory bullae are equally inflated, thus creating the impression of larger bullae in *delamensis*.

*M. b. aequatorius* differs from *M. b. delamensis* in darker color and more pronounced subauricular and postauricular spots and generally larger size. The skull is wider across the zygomatic arches, the auditory bullae are more inflated, and the braincase is larger.

REMARKS: The above comparisons of pelages were, so far as possible, made on animals taken during the same month. As may be noted under the remarks section of *M. b. aequatorius*, there is a seasonal difference in pelage color.

Specimens in the British Museum from the Jebel Marra may be referable to *Mus bellus*, but since no skulls are available I prefer not to list them. The skins are more nearly like *M. b. delamensis* than any of the other kinds but it would seem improbable that the Jebel Marra animals would be the same.

*Mus bellus gondokorae* Heller

FIGURE 7,c

*Mus bellus gondokorae* Heller, Smithsonian Misc. Coll., vol. 56, No. 17, p. 8, February 28, 1911. (Gondokoro.)

SPECIMENS EXAMINED: Seventeen, from: Gondokoro, 3 (1, BM); Malek, 9 (BM); Mongalla, 2 (BM); Juba, 1 (BM); Kenisa, 1 (BM); Bahr-el-Ghazal, 1 (BM).

MEASUREMENTS: The type, an adult male, measures as follows: Length of head and body 60; length of tail 43; length of hind foot 13;

length of ear 8; condyloincisive length of skull 15.9; crown length of upper toothrow 2.9; greatest width across zygomatic arches 9.0; least interorbital width 3.3; length of nasals 6.2; width of rostrum at level of antorbital foramen 2.5.

REMARKS: When specimens of this subspecies are compared with specimens of *M. b. aequatorius* they are found to differ in longer head and body, longer tail, generally longer hind foot, and darker coloration in comparable pelages. The subauricular spot is markedly less developed. The upper toothrow is longer and the rostrum is wider.

*Mus musculoides emesi* Heller

*Mus musculoides emesi* Heller, Smithsonian Misc. Coll., vol. 56, No. 17, p. 5, February 28, 1911. (Kabula Muliro, Uganda.)

SPECIMENS EXAMINED: Twelve, from: Lotti Forest, 5 (3, MCZ); Katire, 3 (MCZ); Torit, 2 (MCZ); Lafon, 2 (MCZ).

MEASUREMENTS: The only complete specimen is an adult male from Lotti Forest. It has the following measurements: Length of head and body 65; length of tail 52; length of hind foot 15; length of ear from notch 10; condyloincisive length of skull 18.1; crown length of upper toothrow 3.3; least interorbital width 3.8; length of nasals 7.6; width of rostrum at level of antorbital foramen 2.6.

REMARKS: This small series of mice agrees in most details with the type of *M. m. emesi*. There are, though, some peculiarities of the cranium which are not observable in the type. These differences may be due to age or sex, but skin color and external measurements do agree with the type of *emesi*.

This species can possibly be confused with *Mus triton*, but it can be distinguished from that species by smaller size and the clear white hairs of the belly. It can also be confused with the dark phase of *Mus bellus*, but can be differentiated by the lack of a dorsal stripe and by the much larger size of M<sup>1</sup>.

*Mus tenellus acholi* Heller

FIGURE 7,*d*

*Mus tenellus acholi* Heller, Smithsonian Misc. Coll., vol. 56, No. 17, p. 6, February 28, 1911. (Rhino Camp, Lado Enclave.)

SPECIMEN EXAMINED: One, from Torit.

MEASUREMENTS: An adult female from Torit measures as follows: Length of head and body 71; length of tail 33; length of hind foot 14; length of ear from notch 11.5; condyloincisive length of skull 18.9; crown length of upper toothrow 3.4; least interorbital width 3.7; length of nasals 7.5; width of rostrum at level of antorbital foramen 2.6.

REMARKS: In the only specimen available there are certain differences from the type of *M. t. acholi*. These differences are in the size of the bullae, the size of  $M^2$ , length of the anterior palatine foramina, and, externally, in a somewhat darker color. Whether these observable differences are geographic, individual, or seasonal cannot be determined at this time. Therefore, this specimen is being referred to *M. t. acholi* on a provisional basis.

*M. t. acholi* may be distinguished from the subspecies of *Mus bellus* occurring in the same area by its generally larger ear, longer head and body, greater size of  $M^1$ , greater length of the upper tooth-row, and by the generally larger skull.

*Mus tenellus tenellus* (Thomas)

FIGURE 7,*d*

*Leggada tenella* Thomas, Proc. Zool. Soc. London, pt. 1, p. 298, August 6, 1903. (Roseires, Blue Nile.)

SPECIMEN EXAMINED: The type only, in BM.

MEASUREMENTS: The measurements of the type, an adult female, are as follows: Length of head and body 50; length of tail 35; length of hind foot 11.5; length of ear 8; greatest length of skull 17.2; condyloincisive length 16.2; length of anterior palatine foramina 3.8; crown length of upper toothrow 2.9; least interorbital width 3.1; width of rostrum at level of antorbital foramen 2.3; length of nasals 6.7; greatest width across zygomatic arches 8.8.

REMARKS: *Mus tenellus* can usually be distinguished from *Mus bellus* by its shorter tail and shorter hind foot as well as a generally darker dorsal color and less extensive white on the belly. The skull is usually larger in all respects except the auditory bullae, which are of the same size but appear smaller in consequence of the larger skull.

Apparently *tenellus* and its subspecies in the Sudan are not common mice since so few are known in collections.

*Mus triton imatongensis* Setzer

*Mus triton imatongensis* Setzer, Journ. Washington Acad. Sci., vol. 43, No. 10, p. 334, October 22, 1953. (Gilo, Imatong Mountains.)

SPECIMENS EXAMINED: Twenty-one, all from Gilo, Imatong Mountains (9, MCZ).

MEASUREMENTS: Average and extremes of seven adult males and four adult females from Gilo are, respectively: Length of head and body 71.5 (66–79), 77.5 (72–81); length of tail 53.5 (50–56), 54 (53–57); length of hind foot 16 (14–17), 16.5 (16–17); length of ear from notch 8.5 (7.0–9.0), 8.6 (8.0–10.0); condyloincisive length of skull 19.5 (19.5), ?; greatest width across zygomatic arches 10.5 (10.3–

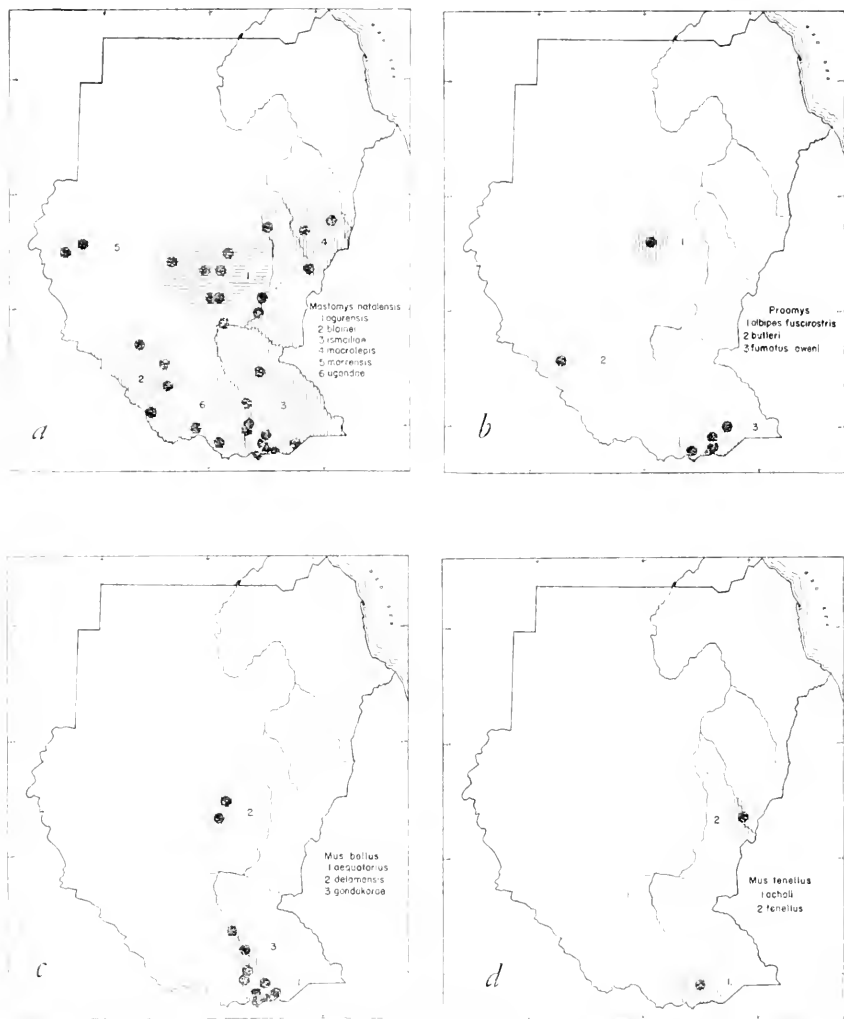


FIGURE 7.—Distribution of *Mastomys* (in part), *Praomys*, and *Mus* in the Anglo-Egyptian Sudan. (Scale: 1 inch=400 miles.)

10.8), 10.8 (10.8); length of nasals 7.9 (7.8–8.1), 8.3 (8.2–8.5); least interorbital width 3.9 (3.9); 3.9 (3.8–4.0); crown length of upper tooththrow 3.6 (3.5–3.7), 3.6 (3.5–3.7).

REMARKS: These specimens were all taken in grass either in coffee plantations or along forest streams. The characters separating *imatongensis* from the nominate form from Uganda are the greater development of the auditory bullae and the vaulting of the cranium.

Specimens taken in June are somewhat lighter in color than those taken in January.



*Lophuromys aquilus margarettae* Heller

*Lophuromys aquilus margarettae* Heller, Smithsonian Misc. Coll., vol. 59, No. 16, p. 7, July 5, 1912. (Mount Gargues, Matthews Range, British East Africa.)

**SPECIMENS EXAMINED:** Twenty-three, from: Gilo, Imatong Mountains, 11 (6, MCZ); *Lotti Forest*, Imatong Mountains, 4 (1, MCZ); Magwe, 36 miles southwest of Torit, 1 (MCZ); *Issore*, Imatong Mountains, 2 (BM); *Lomoling*, Imatong Mountains, 1 (BM); *Kitibol*, Imatong Mountains, 2 (BM); *Kipia*, Imatong Mountains, 2 (BM).

**MEASUREMENTS:** There are no adult females of this species in the collection, but the measurements of an adult male from Gilo, Imatong Mountains, are as follows: Length of head and body 132; length of tail 70; length of hind foot 21; length of ear 11; condyloincisive length of skull 28.4; posterior edge of  $M^3$  to front of incisor 14.5; length of upper toothrow 4.9; least interorbital width 5.9; length of nasals 12.8; width of rostrum at level of antorbital foramen 3.7; width across  $M^1$ - $M^1$  6.6.

**REMARKS:** In general these specimens agree with the type of *margarettae* but are somewhat paler in dorsal color. The specimens from the Lotti Forest are markedly paler. It may be that these represent a new subspecies but until the amount of variation, individual, sexual, and specific, is known I feel that it is best to refer these to *margarettae* as being indicative of their nearest relationship.

There are certain peculiarities of the skull of the two species *aquilus* and *sikapusi* that may be of significance in determining the species. In the latter there is a pronounced bony tuberosity at the posterior end of the bony palate which is marked in immatures and becomes progressively more noticeable as the animal ages. This tuberosity is inconspicuous in young specimens of *aquilus* and in adulthood is about as in young of *sikapusi*. In addition, the sculpturing along the lateral margins of the palate is more pronounced at all age levels in *sikapusi* and the posterior palatine foramina are, in general, longer and more open than in *aquilus*. This size and shape of the posterior palatine foramina in certain instances shows an overlap, so the degree of usefulness is questionable. However, combining the color of the dorsum and the cranial features as outlined above as well as under the remarks section for *sikapusi pyrrhus*, the animals from the Sudan can be distinguished with a certain degree of accuracy.

*Lophuromys sikapusi pyrrhus* Heller

*Lophuromys pyrrhus* Heller, Smithsonian Misc. Coll., vol. 56, No. 17, p. 10, February 28, 1911. (Rhino Camp.)

**SPECIMENS EXAMINED:** Twenty-three, from: Gilo, Imatong Mountains, 15 (1, MCZ); Nimule, 4 (MCZ); Katire, 2 (1, MCZ); Yambio District, 2 (BM).

MEASUREMENTS: An adult male and an adult female from Gilo, Imatong Mountains measure, respectively, as follows: Length of head and body 119, 125; length of tail 69, 75; length of hind foot 22, 22; length of ear 11, 13; condyloincisive length of skull ?, 28.4; posterior edge of  $M^3$  to front of incisor 14.2, 14.0; crown length of upper toothrow 4.8, 4.8; greatest width across zygomatic arches 15.2, 14.5; least interorbital width 5.9, 5.8; length of nasals 11.6, 13.0; width of rostrum at level of antorbital foramen 3.5, 3.5; width across  $M^2$ - $M^1$  6.7, 6.6.

REMARKS: This species is difficult to distinguish from *L. aquilus* in all of the specimens examined. In general, *sikapusi* is darker in color than is *aquilus*. In addition to the darker dorsal color, the ratio between the width of the anterior ends of the auditory bullae and the width of the posterior choanae averages about 60 percent, which means that the choanae are narrower in proportion to the space between the bullae. This same ratio in *aquilus* is in the neighborhood of 80 percent. The coloration of the belly is extremely variable in both species and apparently is no criterion for separating the two kinds.

The amount of cranial variation between individuals of the two species is so great that only averages may be used to determine the correct allocation of specimens.

*Acomys albigena* Heuglin

*Acomys albigena* Heuglin. Reise in Nordost-Afrika, vol. 2, p. 68, 1877. (Bogos Country, Abyssinia.)

SPECIMENS EXAMINED: Four, all in BM, from Gallabat.

MEASUREMENTS: An adult male from Gallabat measures as follows: Length of head and body 94; length of tail 100; length of hind foot 19; length of ear 16; greatest length of skull 30.0; condyloincisive length 26.7; length of anterior palatine foramina 7.1; crown length of upper toothrow 5.0; least interorbital width 4.7; width of rostrum at level of antorbital foramen 3.1; length of nasals 11.9; greatest width across zygomatic arches 13.4.

REMARKS: This species is darker in color than any normally colored *Acomys* in the Sudan. There is a blackish stripe along the mid-dorsal line shading over the sides into a dark reddish buff. Belly, hands and feet are pure white. The tail, instead of being rather uniformly colored, as in other kinds, is dark above and white below, thus presenting a bicolored aspect.

*Acomys cahirinus cineraceus* Fitzinger and Heuglin

## FIGURE 5, a

*Acomys cineraceus* Fitzinger and Heuglin, Sitzb. K. Akad. Wiss. Wien, vol. 54, sec. 1, p. 573, 1866. (Doka, eastern Sennar, between the Atbara and Rahad Rivers.)

SPECIMENS EXAMINED: Eleven, all in BM, from: Khartoum, 1; *Abu Haraz*, 1; El Kowa, 2; Kamisa, Dinder River, 4; Singa, 1; Abu Ushar, 2.

MEASUREMENTS: An adult male from El Kowa measures as follows: Length of head and body 193; length of hind foot 15.5; length of ear 15; greatest length of skull 27.3; condyloincisive length 25.1; length of anterior palatine foramina 6.3; crown length of upper toothrow 4.2; least interorbital width 4.5; width of rostrum at level of antorbital foramen 3.1; length of nasals 10.5; greatest width across zygomatic arches 13.2.

REMARKS: The single specimen available from Khartoum shows intergrading characters in color and shape of the pterygoid region with *A. cahirinus hunteri*.

*Acomys cahirinus hunteri* De Winton

## FIGURE 5, a

*Acomys hunteri* De Winton, Nov. Zool., vol. 8, p. 401, Dec. 31, 1900. (Plain of Tokar, Suakin.)

SPECIMENS EXAMINED: Thirteen, all in BM, from: Erkowit, 4; Tokar, 2; Sinkat, 1; Kerma, 2; Shereik, 1; Merowe, 2; *Katul Hills*, 1.

MEASUREMENTS: The measurements of an adult male from Tokar are as follows: Length of head and body 117; length of hind foot 16; length of ear 16; greatest length of skull 28.4; condyloincisive length 26.0; length of anterior palatine foramina 6.6; crown length of upper toothrow 3.8; least interorbital width 4.7; width of rostrum at level of antorbital foramen 3.3; length of nasals 10.5; greatest width across zygomatic arches 13.7.

REMARKS: Specimens from Kerma, Shereik, and Merowe are intergrades in color and size of auditory bullae with *A. c. cahirinus*. However, since the intermediacy of character is found in only these two features and the rest of the characters are like *hunteri* they are referred to that subspecies.

*Acomys hystrella* Heller

## FIGURE 5, a

*Acomys hystrella* Heller, Smithsonian Misc. Coll., vol. 56, No. 17, p. 13, Feb. 28, 1911. (Nimule.)

SPECIMENS EXAMINED: Twenty-seven, from: Nimule, 12; 4, MCZ; 20 miles northeast of Nimule, 2; Torit, 1; 20 miles west of Torit, 2;

Moli, 35 miles west of Torit, 2 (MCZ); Lafon, 60 miles north of Torit, 3 (MCZ); Opari, 25 miles north-northeast of Nimule, 3 (MCZ); Okaru, 25 miles west of Torit, 2 (MCZ).

MEASUREMENTS: An adult male and an adult female from Nimule measure, respectively, as follows: Length of head and body 100, 101; length of tail 90, 105; length of hind foot 18, 18; length of ear 12, 14; greatest length of skull 28.6, 29.0; condyloincisive length 26.0, 26.3; crown length of upper toothrow 4.9, 4.5; width of rostrum at level of antorbital foramen 6.0, 6.1; least interorbital width 4.7, 4.8; greatest width across zygomatic arches 13.9, 13.8; length of nasals 10.8, 11.2.

REMARKS: These specimens vary somewhat from the type series of *hystrella* in that they present a slightly redder appearance. This may be due, however, to the present skins being fresher and less faded than the original series. In three of the specimens in the fresh series, the grayish color on the back is more pronounced than in the rest. The skulls, however, are somewhat narrower than in the type series, but this is the only departure in cranial features.

*Acomys intermedius* Wettstein

FIGURE 8,a

*Acomys intermedius* Wettstein, Anz. K. Akad. Wiss. Wien, Math.-Nat., vol. 53, p. 161, 1916. (Dilling.)

SPECIMENS EXAMINED: Eight, all in BM, from: 60 miles west of Obeid, 2; 75 miles north of El Obeid, 1; 50 miles west of El Obeid, 1; 20 miles west of Nahud, 1; 40 miles west of Nahud, 1; 10 miles east of Nahud, 1; 10 miles west of Nahud, 1.

MEASUREMENTS: An adult male from 20 miles west of Nahud measures as follows: Length of head and body 94; length of tail 86; length of hind foot 16; length of ear 14; length of anterior palatine foramina 6.1; crown length of upper toothrow 4.0; least interorbital width 4.4; width of rostrum at level of antorbital foramen 2.9; length of nasals 9.8; greatest width across zygomatic arches 12.3.

REMARKS: There is no evidence of intergradation exhibited in any of the specimens examined, so that while these animals resemble *cahirinus* they appear not to interbreed with them and are so left as a full species until a complete study is done on the genus as a whole.

*Acomys lowei*, new species

FIGURE 8,a

TYPE: BM No. 23.1.1.270, adult male, skin and skull, from 40 miles west of El Fasher, Darfur Province, Anglo-Egyptian Sudan. Obtained Feb. 13, 1921, by Iynes and Lowe, original No. 477.

**SPECIMENS EXAMINED:** Sixteen, all in BM, from: El Fasher, 15; 40 miles west of El Fasher, 1.

**DIAGNOSIS:** Upperparts near Mars Yellow, underparts, cheeks, hands, feet, suborbital and supra-auricular spots pure white. Skull relatively massive, rostrum long and narrow, braincase moderately well inflated, anterior palatine foramina relatively long, bullae moderately well inflated.

**MEASUREMENTS OF THE TYPE SPECIMEN:** Length of head and body 94; length of tail 93; length of hind foot 17; length of ear 15; greatest length of skull 28.9; condyloincisive length 26.0; length of anterior palatine foramina 6.6; crown length of upper toothrow 4.6; least inter-orbital width 4.9; width of rostrum at level of antorbital foramen 3.1; length of nasals 11.2; greatest width across zygomatic arches 13.6.

**COMPARISONS:** From *Acomys cahirinus cineraceus* as known by specimens from El Kowa, *A. lowei* differs in markedly lighter color, less arched skull, larger bullae, longer anterior palatine foramina, longer rostrum, and longer nasals.

From *Acomys cahirinus cahirinus* from Giza, Egypt, *A. lowei* differs in markedly lighter color. The skull is more inflated in the region of the braincase, the nasals are somewhat longer, the auditory bullae are less inflated, there is a somewhat different shape in the pterygoid region, the upper incisors are narrower, and the anterior palatine foramina are somewhat shorter and more bowed laterally.

From *Acomys intermedius* from 20 miles west of Nahud, *A. lowei* differs in lighter, brighter color and lighter colored tail. The skull is larger and more robust in all respects.

From *Acomys cahirinus hunteri* from Erkowit, *A. lowei* differs in lighter color, somewhat smaller skull, and markedly smaller auditory bullae.

**REMARKS:** These specimens were originally identified as *Acomys witherbyi* by Thomas in the Darfur report of 1923. Since that time the name *witherbyi* has been shown to be a synonym of *A. cineraceus*, which is now considered to be only a subspecies of *A. cahirinus*. Since the animals from the vicinity of El Fasher vary from the animals from El Kowa and its environs as set forth under the section on comparisons, it is obvious that they are not closely allied. When the genus *Acomys* is studied in detail probably many more of the species will fall as synonyms or be relegated to subspecific status, but until the genus is studied I do not see the advantage of arbitrarily relegating all species to subspecific status of the earliest named species in the genus such as has been done in the recent book of Ellerman, Morrison-Scott, and Hayman (1953) on the mammals of Southern Africa.

*Acomys percivali* Dollman

*Acomys percivali* Dollman, Ann. Mag. Nat. Hist., ser. 8, vol. 8, p. 126, July, 1911.  
(Chanler Falls, British East Africa.)

SPECIMENS EXAMINED: Thirteen, from: Ikoto, 3 (1, MCZ); Torit, 1; Lafon, 60 miles north of Torit, 1 (MCZ); Mura, *Lofit Hills*, 1 (MCZ); *Labalwa*, 5 miles east of Torit, 7 (MCZ).

MEASUREMENTS: An adult male from Torit and an adult female from Ikoto measure, respectively, as follows: Length of head and body 97, 100; length of hind foot 15.5, 16; length of ear 14, 14; greatest length of skull 26.6, 26.6; condyloincisive length 23.9, 24.0; crown length of upper tooththrow 4.3, 4.2; width of rostrum at level of antorbital foramen 2.9, 3.1; least interorbital width 4.7, 4.7; length of nasals 10.6, 10.2; greatest width across zygomatic arches 12.7, ?.

REMARKS: This dark species of spiny mouse is readily distinguished from *A. w. argillaceus* by its much darker color and larger skull. It may be distinguished from *A. hystrella*, with which it occurs, by its darker color, shorter hind foot, relatively larger skull, flatter braincase, shorter, more constricted anterior palatine foramina, and the smaller interpterygoid fossae.

*Acomys wilsoni argillaceus* Hinton and Kershaw

*Acomys wilsoni argillaceus* Hinton and Kershaw, Ann. Mag. Nat. Hist., ser. 9, vol. 6, p. 101, July, 1920. (Mongalla.)

SPECIMENS EXAMINED: Thirteen, from: Torit, 6 (3, MCZ); Ngaboli, 47 miles north of Torit, 1 (MCZ); Longairo, 20 miles east of Torit, 1 (MCZ); Malek, 5 (BM).

MEASUREMENTS: An adult male from Ngaboli and an adult female from Torit measure, respectively, as follows: Length of head and body 128, 118; length of tail 49, 45; length of hind foot 13, 12.5; length of ear 10, 10; greatest length of skull 23.7, 22.5; condyloincisive length 21.6, 20.1; crown length of upper tooththrow 3.7, 3.6; width of rostrum at level of antorbital foramen 2.8, 2.7; least interorbital width 4.6, 4.2; greatest width across zygomatic arches 11.6, 11.3; length of nasals 8.9, 8.7.

REMARKS: All of the above specimens agree in detail with the type of *argillaceus* and differ from *A. w. wilsoni* and *A. w. ablutus* in a darker dorsal color. This darker dorsal color is obtained by the lessening of the reddish subterminal bands and the lengthening of the blackish terminal bands of the spines. This species may be distinguished from other species of *Acomys* by its speckled appearance dorsally.

*Cricetomys gambianus grahami* Hinton

*Cricetomys gambianus grahami* Hinton, Ann. Mag. Nat. Hist., ser. 9, vol. 4, p. 283, October, 1919. (Nuba Mountains.)

SPECIMEN EXAMINED: One, the type, in BM.

MEASUREMENTS: The measurements of the type, an adult male, are as follows: Length of head and body 300; length of tail 357; length of hind foot 70 (dry, 65); length of ear 35; condylobasal length of skull 62.4; greatest width across zygomatic arches 31.7; least inter-orbital width 9.3; length of nasals 25.2; length of anterior palatine foramina 5.4; crown length of upper toothrow 10.4.

REMARKS: The two specimens, in subadult pelage, from Equatoria Province and referred only to the species *gambianus*, rather closely approach *grahami* in color but owing to the immature condition of the skulls little can be said about relationships.

The types of the various subspecies of *C. gambianus* examined in the British Museum are all very similar to one another, but minute differences in cranial details and pelage color do exist. Whether these are of subspecific worth is not at present determinable. It would be highly desirable to have series of this animal from the several type localities to determine the degree of variation in each population.

*Cricetomys gambianus* subsp.

SPECIMENS EXAMINED: Two, from: 6 miles southwest of Torit, 1; Nimule, 1.

REMARKS: No subspecies allocation can be made on the two specimens examined since both of them are immatures. It is generally accepted that all members of this genus in the Sudan are conspecific and should be referred to *gambianus*.

The amount of variation existing in this genus is extreme. How much of it is due to age, sex or geography is a moot question. The genus is in need of a thorough revision based on more than one or two specimens from each locality.

## Subfamily DENDROMURINAE

*Dendromus mesomelas* subsp.

SPECIMENS EXAMINED: Two, both in MCZ, from: Gilo, 40 miles south-southeast of Torit.

REMARKS: These two specimens are somewhat darker than *D. m. percivali* from Mount Gargues, British East Africa. The external measurements agree rather well with *percivali*, but the skulls of the Gilo specimens, even though adult, are markedly smaller.

It is apparent that these animals from the Imatong Mountains are different from any of the surrounding kinds, but owing to the broken condition of the skulls and there being only the two specimens I feel it best to identify them only at the specific level.

*Dendromus pumilio lineatus* Heller

*Dendromus lineatus* Heller, Smithsonian Misc. Coll., vol. 56, No. 17, p. 4, Feb. 28, 1911. (Rhino Camp, Lado Enclave.)

**SPECIMENS EXAMINED:** Eight, from: Lokwi, 25 miles south of Torit, 3; Obbo, 4; Loa, 18 miles north of Nimule, 1 (MCZ).

**MEASUREMENTS:** An adult male from Loa and an adult female from Lokwi measure, respectively, as follows: Length of head and body 64, 58; length of tail 87, 85; length of hind foot 18, 17; length of ear 10, 9; greatest length of skull 20.5, 20.2; condyloincisive length 18.5, 17.9; least interorbital width 3.2, 3.2; length of nasals 7.5, 7.6; width of rostrum at level of antorbital foramen 2.5, 2.6; crown length of upper toothrow 3.3, 3.2.

**REMARKS:** The type specimen of *D. p. lineatus* has a pronounced middorsal black stripe. None of the specimens in the present series shows this intense black stripe, but all agree with the remainder of the type series of *lineatus* in showing only a faint suggestion of this marking. It is quite apparent that Heller selected the most strikingly marked specimen, rather than an average one, to name as the type.

In referring *lineatus* to *D. pumilio* I am accepting the work of Bohmann (1942).

*Steatomys aquilo* Thomas and Hinton

FIGURE 8,b

*Steatomys aquilo* Thomas and Hinton, Proc. Zool. Soc. London, p. 264, July 6, 1923. (Niurinya, Jebel Marra.)

**SPECIMEN EXAMINED:** The type.

**MEASUREMENTS:** Only external measurements are available for this species since the skull is badly broken. Those measurements of the type are as follows: Length of head and body 69; length of tail 39; length of hind foot 14; length of ear 13.

**REMARKS:** The color is light brownish gray above, gradually merging over the sides into the pure white of the belly. The tail is markedly bicolor, being of the color of the body above and white below.

No accurate comments can be made about the relationships of this species since it is known only from the type, the skull of which is badly broken.



*Steatomys gazellae* Thomas and Hinton

FIGURE 8,b

*Steatomys gazellae* Thomas and Hinton, Proc. Zool. Soc. London, p. 265, July 6, 1923. (Temburas.)

SPECIMEN EXAMINED: The type.

MEASUREMENTS: There are no external measurements available for the type, an adult male, but the skull measures as follows. Condylolincisive length 24.0; length of anterior palatine foramina 5.1; crown length of upper tooththrow 4.5; least interorbital width 4.3; width of rostrum at level of antorbital foramen 3.4.

REMARKS: The color of the pelage is dark brown above, passing over the sides and abruptly terminating in the white of the belly. The auditory bullae are large and the anterior palatine foramina are widely open.

Again, no comment can be made on the relationship of this species since it is known only from the type specimen.

*Steatomys thomasi*, new species

FIGURE 8,b

TYPE: CNHM No. 79517, adult male, skin and skull, from Torit, Equatoria Province, Anglo-Egyptian Sudan. Obtained January 26, 1952, by J. S. Owen.

SPECIMENS EXAMINED: Twenty-three, from: Torit, 22 (2 MCZ); Ikoto, 1.

DIAGNOSIS: General over-all dorsal color near Buffy Brown abruptly terminating on sides in the pure white of the belly. Tail indistinctly bicolor. Dorsal surfaces of hands and feet, entire underparts, upper lips, and subauricular spot pure white. Skull of average size for the genus, upper cheekteeth relatively large, anterior palatine foramina large but straight-sided, auditory bullae relatively large, and interorbital region relatively narrow.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 70; length of tail 32; length of hind foot 12; length of ear 10; greatest length of skull 20.5; condylolincisive length 18.8; greatest width across zygomatic arches 10.6; crown length of upper tooththrow 3.1; least interorbital width 3.4; width of rostrum at level of antorbital foramen 2.9; length of nasals 8.0.

COMPARISONS: From *Steatomys aquilo*, *Steatomys thomasi* differs in more open anterior palatine foramina, and markedly darker colored upper incisors whose anterior face is much more strongly curved, that is, the radius of a circle formed by the curve of the incisors is markedly less. Since the rest of the skull of the type of *aquilo* is so

badly broken, these are the only characters that can be set forth as distinguishing these two kinds.

*Steatomys thomasi* differs from *Steatomys gazellae* in lighter color, smaller body-size and markedly smaller skull.

From *Steatomys athi*, *Steatomys thomasi* may be distinguished by its generally smaller size and somewhat lighter color. The skull is markedly smaller in all respects.

REMARKS: The northern species of *Steatomys* are badly in need of revision. It is quite probable that the species *aquilo*, *gazellae*, *athi*, and *thomasi* are merely subspecies of the same species, but, until more specimens of *aquilo* and *gazellae* are known and intermediate areas collected, I feel it is better to record these names as species.

### Subfamily Otomyinae

#### *Otomys orestes giloensis* Setzer

*Otomys orestes giloensis* Setzer, Journ. Washington Acad. Sci., vol. 43, No. 10, p. 334, October 22, 1953. (Gilo, Imatong Mountains.)

SPECIMENS EXAMINED: Nine, all from Gilo.

MEASUREMENTS: The measurements of two males and two females from Gilo are, respectively, as follows: Length of head and body 160, 151, 161, 170; length of tail 72, 69, 77, ?; length of hind foot 29, 28, 28, 27; length of ear 17, 15, 17, 20; condyloincisive length of the skull 35.1, ?, 34.7, 33.7; alveolar length of upper toothrow 8.8, 8.8, 8.8, 8.8; length of anterior palatine foramina 6.9, 6.3, 6.6, 6.3; greatest width across zygomatic arches 18.8, 17.9, 18.5, ?; least interorbital width 4.5, 4.6, 4.6, 4.5; length of nasals 16.6, 14.7, 15.7, 15.4.

REMARKS: The above specimens were trapped in heavy litter on the forest floor.

### Family GLIRIDAE

#### Subfamily Graphiurinae

#### *Graphiurus murinus marrensis*, new subspecies

#### FIGURE 8,c

TYPE: BM No. 23.1.1.115, adult female, skin and skull, from Kulme, Wadi Aribo, 3,300 ft., Darfur Province, Anglo-Egyptian Sudan. Obtained September 23, 1921, by Lynes and Lowe, original No. 922.

SPECIMENS EXAMINED: Eight, all in BM, from: Kulme, Wadi Aribo, 4; Zalingei, 2; Jebel Marra, 2.

DIAGNOSIS: Upperparts near Grayish Olive, shading over the sides into the white of the belly. Hands, feet, and tip of tail white. All hairs plumbeous at base.

Skull relatively large, braincase well inflated, zygomata widely flaring, nasals relatively long, interorbitum relatively narrow, auditory bullae strongly inflated, posterior choanae wide, and pterygoid fossae small.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 107; length of tail 63; length of hind foot 17; length of ear 17; condylobasal length of skull 23.6; greatest width across zygomatic arches 15.7; least interorbital width 4.1; crown length of upper tooth-row 3.3; condyloincisive length 25.2; length of nasals 11.3; width of rostrum at level of antorbital foramen 6.1.

COMPARISONS: *Graphiurus murinus marrensis* differs from *G. m. sudanensis* in somewhat paler color, lighter belly, and lighter colored tail. The skull has more open posterior choanae, larger bullae, wider zygomatic arches, wider rostrum, and more inflated braincase.

From *G. m. butleri*, *G. m. marrensis* differs in somewhat lighter color throughout. The skull is somewhat smaller, the auditory bullae are more inflated, the posterior choanae are more open, the rostrum is wider, and the braincase is more inflated.

While no specimens of *Graphiurus orobinus* have been available, it would seem that *G. m. marrensis* can be distinguished by its longer hind foot.

REMARKS: No actual intergradation has been demonstrated in the dormice of the Sudan, but the characters by which the kinds may be distinguished from one another are at best only of subspecific rank.

Little distinction can be made between the three kinds known to occur in the Sudan by means of external measurements and in most of the cranial measurements. However, the degree of difference in color, the degree of inflation of the braincase and the auditory bullae, and the configuration of the posterior choanae readily separate these dormice.

***Graphiurus murinus butleri* Dollman**

FIGURE 8,c

*Graphiurus butleri* Dollman, Ann. Mag. Nat. Hist., ser. 8, vol. 9, p. 319, March 1912. (Jebel Ahmed Aga.)

SPECIMENS EXAMINED: Six, all in BM, from: Jebel Ahmed Aga, 1; Delami, 3; Nuba Mountains, 2.

MEASUREMENTS: The cranial measurements of the type, an adult male, are as follows: Condylobasal length of skull 23.9; least interorbital width 4.3; crown length of upper toothrow 3.2; condyloincisive length 25.5; length of nasals 11.1; width of rostrum at level of antorbital foramen 5.9.

REMARKS: While no actual intergradation can be demonstrated between *butleri*, *sudanensis*, or the kinds to the west, I feel that the degree of difference between these three kinds of dormice is of only subspecific worth; therefore they are all treated as subspecies of the earlier named *Graphiurus murinus*.

***Graphiurus murinus sudanensis* Setzer**

FIGURE 8,c

*Graphiurus murinus sudanensis* Setzer, Journ. Washington Acad. Sci., vol. 43, No. 10, p. 333, October 22, 1953. (Torit.)

SPECIMENS EXAMINED: Twenty-three, from: Torit, 18 (7, MCZ); Obbo, 1; *Labalwa, 5 miles east of Torit*, 1 (MCZ); Mongalla, 1 (BM); Malek, 2 (BM).

MEASUREMENTS: Two males and two females from Torit measure, respectively, as follows: Length of head and body 95, 88, 94, 93; length of tail 76, ?, 76, 82; length of hind foot 17, 18, 18, 18; length of ear 16, 16, 15, ?; condylobasal length of skull 21.7, 20.9, 21.2, 22.2; greatest width across zygomatic arches 15.0, ?, 13.9, 14.6; least inter-orbital width 4.5, 4.1, 4.1, 4.2; crown length of upper toothrow 3.1, 3.0, 3.0, 3.1; condyloincisive length 23.3, 22.3, 22.6, 23.8; length of nasals 9.4, 9.0, 9.4, 9.6; width of rostrum at level of antorbital foramen 5.4, 5.3, 5.2, 5.6.

REMARKS: Apparently these small dormice are not restricted to any one habitat since they have been taken in trees, grassland, or rocky hills and in native huts. The type was taken in a native hut in Torit.

***Graphiurus orobinus* (Wagner)**

FIGURE 8,c

*Myoxus orobinus* Wagner, Arch. Naturg., vol. 11, sec. 1, p. 149, 1845. (Sennaar.)

SPECIMENS EXAMINED: None.

REMARKS: There have been no specimens of this dormouse available to me for study. From the description, as given by Wagner, this is a very small animal which is apparently unrelated to the *murinus* group.

The entire genus is in need of revision.

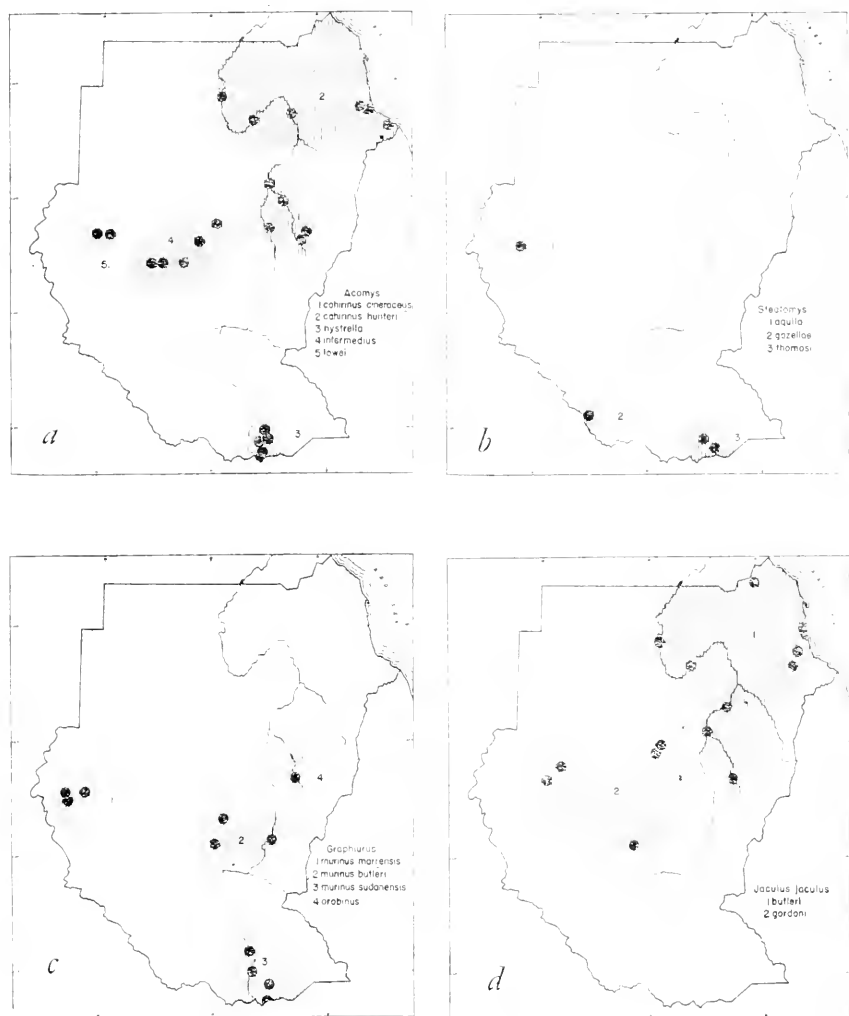


FIGURE 8.—Distribution of *Acomys*, *Steatomys*, *Graphiurus*, and *Jaculus* in the Anglo-Egyptian Sudan. (Scale: 1 inch=400 miles.)

Family DIPODIDAE  
Subfamily Dipodinae

*Jaculus jaculus butleri* Thomas

FIGURE 8,*d*

*Jaculus jaculus butleri* Thomas, Ann. Mag. Nat. Hist., ser. 9, vol. 9, p. 296, April 1922. (Khartoum.)

SPECIMENS EXAMINED: Forty-three, all in BM, from: Khartoum, 22; Port Sudan, 6; Khor Arbat, 1; Sinkat, 1; Khor Hanoieit, 2; Shendy, 3; Kerma, 3; *Omdurman*, 1; Sennaar, 2; eastern Egyptian Desert, lat.  $21^{\circ}31'$  N., long.  $35^{\circ}$  E., 1; Merowe, 1.

MEASUREMENTS: No external measurements are available, but cranial measurements of an adult male and averages and extremes of three adult females from Khartoum are, respectively, as follows: Greatest length of skull 32.7, 33.0 (32.7–33.5); condyloincisive length 28.8, 28.9 (28.5–29.4); crown length of upper toothrow 4.7, 4.6 (4.5–4.7); greatest breadth across anterior zygomatic processes 23.4, 24.2 (24.2); least interorbital width 11.8, 12.0 (11.8–12.2); length of nasals 12.0, 12.2 (11.8–12.7); width of rostrum at level of antorbital foramen 5.1, 5.3 (5.0–5.5); greatest breadth of braincase 22.4, 22.9 (22.4–23.3).

REMARKS: This subspecies differs from *Jaculus jaculus gordonii* in somewhat darker color, that is, more admixture of black tipped hairs; smaller hind foot; and a decidedly shorter ear. The skulls are quite similar except that the auditory bullae are smaller, the upper cheek-teeth smaller and the toothrow shorter, the rostrum somewhat narrower and shorter, and the lachrymals somewhat larger.

*Jaculus jaculus gordonii* Thomas

FIGURE 8,*d*

*Jaculus gordonii* Thomas, Proc. Zool. Soc. London, p. 299, Aug. 6, 1903. (Kaga Hills, Western Kordofan.)

SPECIMENS EXAMINED: Thirteen, all in BM, from: *Kaga Hills*, 2; Jebel Um Durragh, 1; Jebel Agageh, 1; *Hamra*, 5; Haraza, 2; near El Fasher, 1; 55 miles northeast of El Fasher, 1.

MEASUREMENTS: The type, an adult male, measures as follows: Length of head and body 120; length of tail 200; length of hind foot 66; length of ear 25; greatest length of skull 35.5; condyloincisive length 31.9; crown length of upper toothrow 5.6; greatest breadth across anterior zygomatic processes 24.1; least interorbital width 13.0; length of nasals 13.0; width of rostrum at level of antorbital foramen 6.0; greatest breadth of braincase 24.5.

REMARKS: In some of the above specimens the color is as in the type but in others the color is markedly lighter and brighter. This is not due to season since all of these specimens were taken at approximately the same time of year. The skulls, however, show all of these specimens to be referable to *J. j. gordoni*.

## Suborder HYSTRICOMORPHA

### Family HYSTRICIDAE

#### Subfamily Atherurinae

##### *Atherurus turneri* St. Leger

*Atherura turneri* St. Leger, Ann. Mag. Nat. Hist., ser. 10, vol. 10, p. 231, September 1932 (Kakumega Forest, near Kaimosi, Kenya Colony.)

SPECIMEN EXAMINED: One, from Lokwi, 25 miles south of Torit.

MEASUREMENTS: Measurements of an adult male from Lokwi are as follows: Length of head and body 520; length of tail 130; greatest length of skull 90.5; zygomatic width 46.9; alveolar length of upper toothrow 17.3; length of palate 38.2; length of nasals (median) 22.3; least interorbital width 28.7; least postorbital constriction 25.3; median width of nasals 12.0; breadth across external auditory meatus 40.0.

REMARKS: This single specimen seems to agree in all respects with the type of *turneri*.

### Family THRYONOMYIDAE

##### *Thryonomys gregorianus* subsp.

SPECIMEN EXAMINED: One, in BM, from Char, Didinga Mountains.

MEASUREMENTS: The external measurements of the above specimen, an adult male, are as follows: Length of head and body 500; length of tail 82; length of hind foot 67; length of ear 29.

REMARKS: This single specimen from the Didinga Mountains most closely resembles the nominate race but there are differences in color. Any attempt to assign a subspecific name to this animal would, at best, be only guesswork. I prefer to leave any subspecific identification until such time as additional material is available.

##### *Thryonomys harrisoni harrisoni* Thomas and Wroughton

*Thryonomys harrisoni* Thomas and Wroughton, Ann. Mag. Nat. Hist., ser. 7, vol. 19, p. 384, May 1907. (Loka, 60 miles southwest of Fort Berkeley.)

SPECIMEN EXAMINED: One, the type, in BM.

MEASUREMENTS: The cranial measurements of the type, sex unknown, are as follows: Greatest length of skull 91; length of nasals 30; least interorbital width 28.5; crown length of upper toothrow 16.

REMARKS: The skull of the species *harrisoni* may be distinguished from that of *gregorianus* by its longer and narrower build. From *swinderianus* this species may be recognized by the lack of the anterior cranial inflation.

*Thryonomys swinderianus variegatus* (Peters)

*Aulacodus variegatus* Peters, Reise nach Mossambique, Säugethiere, p. 138, 1852. (Mozambique.)

*Aulacodus semipalmatus* Heuglin, Nova Acta Acad. Caes. Leop.-Carol., Halle, vol. 31, art. 7, p. 5, 1864. (West of Djur River, to Fertit and Niam-Niam country, upper Bahr-el-Ghazal.)

SPECIMEN EXAMINED: One, in BM, from Akanda, Bahr-el-Ghazal.

REMARKS: The cane rats are all similar in external appearance but may be distinguished by their cranial details. The species *swinderianus* has the anterior portion of the skull inflated while in *gregorianus* this portion of the skull is markedly less inflated.

These two species may be further distinguished by the longer bicolor tail in the former and the short concolor tail in the latter.

It is quite apparent that the genus *Thryonomys* needs a thorough revision based on far more material than appears to be extant at this time.

Family BATHYERGIDAE

*Cryptomys ochraceocinereus oweni*, new subspecies

TYPE: CNHM No. 79485, sex unknown, young adult, skin and skull, from Magwe, 36 miles southwest of Torit, Equatoria Province, Anglo-Egyptian Sudan. Obtained November 2, 1951, by J. S. Owen.

SPECIMENS EXAMINED: Four, from: 5 miles east of Torit, 1 (MCZ), Torit, 1 (MCZ); Nagichot, Didinga Hills, 1; Magwe, 36 miles southwest of Torit, 1.

DIAGNOSIS: Upper parts Blackish Brown but little lighter below; hands and feet light brownish above; dorsal head spot, lips, chin, and line on mid throat ending in a spot on the breast, pure white. Skull relatively flat, rostrum narrow, auditory bullae small but well inflated, upper toothrow relatively short, interorbital width relatively small, orbital notch greatly reduced.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 160; length of tail 10; length of hind foot 28; greatest length of skull 42.8; condyloincisive length 41.6; crown length of upper toothrow 6.7; greatest width across zygomatic arches 30.1; least interorbital width



9.3; least postorbital width 9.1; length of nasals 14.3; width of rostrum at level of antorbital foramen 8.3.

COMPARISONS: From *C. o. ochraceocinereus* as known from 400 miles west of Juba, *C. o. oweni* differs in darker color throughout; the skull has the rostrum narrower, the pterygoid fossae smaller, auditory bullae smaller but more inflated ventrally, hard palate markedly narrower, upper toothrow shorter, width across postorbital processes greater, interorbital width less, skull flatter, and the orbital notch markedly reduced.

REMARKS: These specimens from Equatoria Province need no comparison with other named kinds, which are all far removed geographically from this area.

The status of the name *ochraceocinereus* is somewhat in doubt, but until such time as a revisionary study has been made I prefer to refer this new subspecies to that species.

The label on the specimen from Nagichot bears the collectors remark, "Plentiful in mountain-meadows." Unfortunately only the single specimen was obtained and saved.

## Order CARNIVORA

### Family CANIDAE

#### Subfamily Caninae

##### *Canis adustus bweha* (Heller)

*Thos adusta bweha* Heller, Smithsonian Misc. Coll., vol. 63, No. 7, p. 2, June 24, 1914. (Kisumu, British East Africa.)

SPECIMENS EXAMINED: Three, all in BM, from: Chak Chak, 1; Bahr-el-Ghazal, 1; Bor, 1.

MEASUREMENTS: An adult male from Chak Chak has the following measurements: Length of head and body 673; length of tail 279; length of hind foot 182; length of ear 70; greatest length of skull 161.0; condyloincisive length 144.2; length of auditory bullae 21.4; greatest width across zygomatic arches 78.8; least postorbital width 27.9; least interorbital width 28.4; length of nasals 60.0.

REMARKS: *Canis adustus* may be distinguished from *Canis aureus*, with which it apparently occurs, by smaller size, markedly smaller cheekteeth, smaller but more inflated auditory bullae, and the choanae tapering sharply posteriorly. The skin is lighter in color and the hair is shorter; the ears are smaller and decidedly blackish in color as opposed to pale and long in *aureus*.

*Canis aureus soudanicus* Thomas

*Canis variegatus* Cretzschmar, in Rüppell, Atlas zu der Reise im Nördlichen Afrika von Rüppell, pt. 1, Säugethiere, p. 31, 1826. (Nubia and Upper Egypt.) (Not *Canis familiaris variegatus* Gmelin 1788.)

*Canis anthus soudanicus* Thomas, Proc. Zool. Soc. London, p. 295, August 1903. (El Obeid, Kordofan.)

*Canis doederleini* Hilzheimer, Zool. Anz., vol. 30, p. 116, Apr. 17, 1906. (Upper Egypt.)

*Canis thooides* Hilzheimer, Zool. Beob., vol. 47, p. 364, December 1906. (Sennaar.)

*Thos aureus nubianus* Cabrera, Bol. Real Soc. Española Hist. Nat., Madrid, vol. 21, p. 264, Oct. 14, 1921. (New name for *C. variegatus* Cretzschmar.)

SPECIMENS EXAMINED: Ten, all in BM, from: El Obeid, 1; *Sennaar*, 1; Plain of Tokar, 2; 35 miles west of Omdurman, 1; Jebel Marra, 3; *Niurmya*, *Jebel Marra*, 1; *Habissa Wells*, 1.

MEASUREMENTS: An adult male and an adult female from the Jebel Marra measure, respectively, as follows: Length of head and body 577, 661; length of tail 261, 254; length of hind foot 161, 140; length of ear 97, 99; greatest length of skull 160, 149.5; condyloincisive length 151, 140.8; length of auditory bullae 21.0, 20.0; greatest width across zygomatic arches 86.7, 74.4; least postorbital width 27.1, 28.7; least interorbital width 24.7, 23.1; length of nasals 53.9, 51.4.

REMARKS: These jackals are quite uniform in coloration but vary considerably in their cranial details. G. M. Allen (1939, p. 195) notes that Schwarz (1926) considers *soudanicus* to be the same as *nubianus*, which is a new name for *variegatus*. However, if all these jackals are the same, then the oldest available name is *Canis aureus soudanicus*.

*Canis mesomelas elgonae* (Heller)

*Thos mesomelas elgonae* Heller, Smithsonian Misc. Coll., vol. 63, No. 7, p. 3, June 24, 1914. (Guas Ngishu Plateau, Kenya Colony.)

*Thos mesomelas mcmillani* Heller, Smithsonian Misc. Coll., vol. 63, No. 7, p. 3, June 24, 1914. (Mtoto Andei, Kenya Colony.)

SPECIMEN EXAMINED: One, from Ikoto.

MEASUREMENTS: An adult male from Ikoto measures: Length of head and body 680; length of tail 322; length of hind foot 157; length of ear 109; greatest length of skull 146.8; length of palate 69.0; breadth  $M^1-M^1$  47.5; greatest width across zygomatic arches 84.7; least interorbital width 29.9; postorbital constriction 35.2; length of nasals 49.7; breadth of braincase 53.2.

REMARKS: In attempting to identify the only specimen of this jackal in the collection, it was necessary to compare it with specimens of *C. m. elgonae* and *C. m. mcmillani*. In no way does this specimen disagree with either named kind. Heller erected these two subspecies on the basis of the basal hair color of the belly. In *elgonae* the basal

portion is supposed to be plumbeous and in *mcmillani* the basal portion is supposed to be white. However, in the specimens used by Heller, including the types, the hair is plumbeous to the base in all specimens of both kinds. In addition, there is no method by which the skulls of the two kinds may be told apart. It is true that the auditory bullae in the type of *elgonae* are more inflated ventrally than in *mcmillani* but this character breaks down when the type series from the Guas Ngishu Plateau is examined. Therefore, since the name *Thos mesomelas elgonae* has line preference over *Thos mesomelas memillani*, that name will be the one for the *mesomelas* jackals from northern and eastern Kenya Colony and *mcmillani* thus becomes a synonym of *C. m. elgonae*.

***Vulpes pallida pallida* (Cretzschmar)**

*Canis pallidus* Cretzschmar, in Rüppell, Atlas zu der Reise im nördlichen Afrika von Rüppell, pt. 1, Säugethiere, p. 33, 1826. (Kordofan.)

SPECIMENS EXAMINED: Eighteen, all in BM, from: 25 miles west of Omdurman, 1; Shendy, 5; Wad Medani, 1; Suakin, 5; *Wad Ferow*, 1; Kulme, Wadi Aribo, 4; Jebel Marra, 1.

MEASUREMENTS: Average and extreme measurements of three adult males from Shendy are as follows: Length of head and body 382.2 (333–420); length of tail 242.1 (225–270); length of hind foot 103.0 (100–108); length of ear 68.2 (65–71); greatest length of skull 97.5 (96.8–98.7); condyloincisive length 94.3 (93.3–96.0); length of auditory bullae 17.3 (15.9–18.5); greatest width across zygomatic arches 52.3 (51.0–53.6); least postorbital width 20.8 (20.2–21.9); least interorbital width 18.1 (17.1–19.1); length of nasals 31.3 (29.0–33.3).

REMARKS: The specimens from Kulme and the Jebel Marra are not typically *pallida* but average larger in all measurements taken on the skull. They are darker in color than animals from farther east. The skulls have a wider braincase, larger upper molars, and the auditory bullae are, in general, larger and more inflated.

However, the differences set forth are not constant in the few specimens examined, and since there is some overlap of these characters with animals from the eastern Sudan I refer them to the nominate race.

***Vulpes rüppellii rüppellii* (Schinz)**

*Canis rüppellii* (sic) Schinz, Das Tierreich . . . von Cuvier, vol. 4, p. 508, 1825. (Dongola.)

*Canis famelicus* Cretzschmar, in Rüppell, Atlas zu der Reise im nördlichen Afrika von Rüppell, pt. 1, Säugethiere, p. 15, 1826. (Nubian desert and Kordofan.)

SPECIMENS EXAMINED: Five, all in BM, from: Selima Oasis, 100 miles west of Wadi Halfa, 2; Nagashurt, 1; No. 2 Station, between Wadi Halfa and Khartoum, 1; Khor Arbat, 1.

MEASUREMENTS: Cranial measurements of an adult male from Khor Arbat and an adult female from No. 2 Station are, respectively, as follows: Greatest length of skull 110, 106.4; condyloincisive length 106, 101.6; length of auditory bullae 20.2, 19.1; greatest width across zygomatic arches 58.0, 57.1; least postorbital width 20.2, 20.2; least interorbital width 19.7, 19.3; length of nasals 38.4, 34.9.

REMARKS: *V. rüppellii* may be distinguished from *V. pallida* by its more intense reddish color; the longer ears; and the clear anterior face of the foreleg, that is, the blackish stripe on the foreleg of *pallida* is missing in *rüppellii*.

### *Fennecus zerda* (Zimmermann)

*Canis zerda* Zimmermann, Geogr. Geschichte, vol. 2, p. 247, 1780. (Sahara and other regions back of the Atlas Mountains, and in Tripoli.)

*Fennecus arabicus* Desmarest, Dictionnaire d'histoire naturelle, tableau de méthodique des mammifères, p. 18, 1804; Nouveau dictionnaire d'histoire Naturelle, vol. 11, p. 342, 1817. (Barbary, Nubia, Abyssinia.)

*Fennecus brucei* Desmarest, Mammalogie, in Encyclopædia Méthodique, p. 235, 1820. (Libya, Tunis, Algeria, and Sennaar.)

(Other synonyms extralimital to the Sudan.)

SPECIMEN EXAMINED: One, in BM, from Dongola.

MEASUREMENTS: An adult male from Dongola measures as follows: Length of head and body 360; length of tail 290; length of hind foot 92; length of ear 90; greatest length of skull 83.5; condyloincisive length 81.8; length of auditory bullae 19.5; greatest width across zygomatic arches 44.0; least postorbital width 18.0; least interorbital width 15.7; length of nasals 26.5.

REMARKS: The fennec is the smallest of the canids occurring in the Sudan. It may be further differentiated from the rest of the family in the Sudan by its extremely pallid color and by the presence of a small blackish tip on the tail.

### Subfamily Simocyoninae

#### *Lycaon pictus somalicus* Thomas

*Lycaon pictus somalicus* Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 14, p. 98, August 1904. (Gorahai, Somaliland.)

*Lycaon rüppelli* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 415, October 1915. (Bajuda Steppe Region, Anglo-Egyptian Sudan.)

*Lycaon takanus* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 360, October 1915. (Near Khor el Gasch, Taka District, Anglo-Egyptian Sudan.)

(Other synonyms extralimital to the Sudan.)

SPECIMENS EXAMINED: Two, both in BM, from: Bir el Girud, 1; Bahr-el-Ghazal, 1.

MEASUREMENTS: Cranial measurements of an adult male from Bir el Girud are as follows: Greatest length of skull 217; condyloincisive

length 202; length of auditory bullae 29.8; greatest width across zygomatic arches 131.0; least postorbital width 46.3; least interorbital width 46.3; length of nasals 67.1.

REMARKS: The hunting dog may be distinguished from other canids by its larger size, spotted brown and white pattern, and large rounded ear.

## Family MUSTELIDAE

### Subfamily Mustelinae

#### *Ictonyx striatus erythrae* De Winton

FIGURE 9,a

*Ictonyx erythraea* (sic) De Winton, Ann. Mag. Nat. Hist., ser. 7, vol. 1, p. 248, March 1898. (Suakin, Red Sea Coast, Anglo-Egyptian Sudan.)

*Ictonyx erythrae* Anderson and De Winton, in Anderson, Zoology of Egypt, vol. 2, Mammalia, p. 240, 1902. (Correction of misprint.)

SPECIMENS EXAMINED: Eight, all in BM, from: Khartoum, 1; Medani, 1; *Loka*, 1; Roseires, 1; Erkowit, 1; Khor Arbat, 3.

MEASUREMENTS: The average and extremes of cranial measurements for three adult males from Khor Arbat are as follows: Condylolincisive length of skull 58.5 (57.8–59.2); greatest width across zygomatic arches 37.6 (36.1–38.6); least postorbital width 14.6 (13.9–14.9); least interorbital width 15.6 (14.7–16.5); greatest breadth of braincase 28.1 (27.5–28.5).

REMARKS: The specimens from near the Red Sea coast have the dark parts of the pelage reddish black, while the animals from near the Nile are jet black. The one exception to this is the specimen from Khartoum which is intermediate in color.

It may be that the animals from near the Nile should be referred to *I. s. intermedius*. However, upon comparison with the types it seems best to refer these to *erythrae* and note that they are intergrades in color and certain cranial features.

#### *Ictonyx striatus sudanicus* Thomas and Hinton

FIGURE 9,a

*Ictonyx striatus sudanicus* Thomas and Hinton, Proc. Zool. Soc. London, p. 254, July 6, 1923. (Foothills of Jebel Marra, 4,000 feet.)

SPECIMEN EXAMINED: The type, in BM.

MEASUREMENTS: The type, an adult male, measures as follows: Length of head and body 355; length of tail 255; length of hind foot 58; length of ear 24; greatest length of skull 68.5; condylolincisive length 67.1; greatest width across zygomatic arches 38.7; least postorbital width 16.3; least interorbital width 18.0.

REMARKS: This subspecies differs from *erythrae* in having the black pigmented areas reduced, noticeably on the belly. Unless the type is an unusually large animal, *sudanicus* is markedly larger than either *intermedius* or *erythrae*.

***Poecilicitis libyca multivittata* (Wagner)**

*Rhabdogale multivittata* Wagner, in Schreber, Die Säugethiere . . . , Suppl., vol. 2, p. 221, 1841. (Upper Nile.)

*Ictonyx frenata* Sundevall, Kongl. Svenska Vet.-Akad. Handl., Stockholm, p. 212, 1843. (Sennaar.)

SPECIMENS EXAMINED: Three, all in BM, from: Omdurman, 1; Tuli Island, Khartoum, 1; near Jebel Hadoza, 1.

REMARKS: Neither external nor cranial measurements are available for any of the above specimens. However, the specimens are smaller and present a generally darker appearance than do specimens from near Cairo, Egypt. The posterior white rosette is divided in half by a black stripe in these specimens instead of being entire as in the more northern members of the species.

**Subfamily Mellivorinae**

***Mellivora capensis abyssinica* Hollister**

*Mellivora abyssinica* Hollister, Smithsonian Misc. Coll., vol. 56, No. 13, p. 1, October 10, 1910. (Suksukki River, which connects Lake Zwai with Lake Horo Sehal, Ethiopia.)

SPECIMENS EXAMINED: Six, from: Khartoum, 1 (BM); Malek, 2 (BM); Suakin, 1 (BM); Kamisa, 1 (BM); Torit, 1.

MEASUREMENTS: An adult male from Kamisa measures as follows: Length of head and body 725; length of tail 203; length of hind foot 133; length of ear 40; condyloincisive length of skull 137.5; least postorbital width 31.9; least interorbital width 36.2; breadth of braincase 63.7.

REMARKS: The name to be applied to the rats of the Sudan is in doubt. The present specimens are all darker in color and somewhat smaller in size than is the type of *abyssinica*. However, I feel it best to refer these animals to *abyssinica* until such time as the amount of individual and sexual variation is known.

## Subfamily Lutrinae

*Lutra maculicollis nilotica* Thomas

*Lutra concolor* Neumann, Sitzb. Ges. Naturf. Freunde, Berlin, p. 55, 1902. (Addis Ababa, Ethiopia.) (Preoccupied by *Lutra concolor* Rafinesque, 1832, from India.)

*Lutra maculicollis nilotica* Thomas, Ann. Mag. Nat. Hist., ser. 8, vol. 8, p. 726, December 1911. (Upper Nile, Malek, south of Bor.)

SPECIMENS EXAMINED: Five, all in BM, from: White Nile, 2; Bor District, 1; Malek, 2.

MEASUREMENTS: The cranial measurements of an adult male from the Bor District and an adult female from Malek are, respectively, as follows: Condylolincisive length 112.3, 104.5; greatest width across zygomatic arches ?, 63.0; least postorbital width 17.4, 17.0; least interorbital width 19.7, 19.2; breadth of braincase 51.3, 52.0.

## Family VIVERRIDAE

## Subfamily Viverrinae

*Genetta genetta senegalensis* (J. B. Fischer)

*Viverra senegalensis* J. B. Fischer, Synopsis mammalium, p. 170. 1829. (Senegal.)

*Viverra dongolana* Hemprich and Ehrenberg, Symbolae Physicae, Zoologica, Mammalia, dec. 2, folio k, p. 2, September 1832. (Dongola, Anglo-Egyptian Sudan.)

SPECIMENS EXAMINED: Nine, all in BM, from: Erkowit, 1; Khar-toum, 3; Kerma, 1; Port Sudan, 1; Shendy, 2; Sennaar, 1.

MEASUREMENTS: An adult male from Kerma measures as follows: Length of head and body 470; length of tail 360; length of hind foot 80; length of ear 40; greatest length of skull 89.8; condylolincisive length 86.4; greatest width across zygomatic arches 48.0; least postorbital width 12.7; least interorbital width 14.7; breadth of braincase 28.2; length of auditory bullae 12.0.

REMARKS: The white rings of the tail of *G. genetta senegalensis* average nine, and the last ring of the tail is white or whitish. The dorsal and lateral spots are, in general, small and are poorly defined but do not tend to coalesce. The middorsal stripe is distinct and stops well behind the shoulders.

The skull of *G. genetta*, at least in the Sudan, is larger, noticeably in the width across the zygomatic arches and in the postorbital and interorbital width, but the braincase is narrower than in *G. tigrina*.

*Genetta tigrina aequatorialis* Heuglin

*Genetta aequatorialis* Heuglin, Sitzb. K. Akad. Wiss. Wien, Math.-Nat. vol. 54, sec. 1, p. 559, 1866. (West bank of Bahr-el-Abiad, lat. 7° to 8° N., Anglo-Egyptian Sudan.)

**SPECIMENS EXAMINED:** Twenty, from: Torit, 5 (1, MCZ, 1, BM); *Gabt el Meghekid*, 1 (BM); Mongalla, 1 (BM); *Duk Fagwil*, 1 (BM); Malek, 2 (BM); *Moru District*, 3 (BM); Duk, 90 miles northeast of Bor, 1 (BM); *Bor District*, 2 (BM); *Yei District*, 1 (BM); Obbo, 2; *Palwar*, 45 miles south of Torit, 1 (MCZ).

**MEASUREMENTS:** An adult male and an adult female from the Moru District measure, respectively, as follows: Length of head and body 424, 413; length of tail 361, 382; length of hind foot 73, 65; length of ear 37, 39; greatest length of skull 84.7, 81.8; condyloincisive length 81.3, 78.9; greatest width across zygomatic arches 42.9, 42.0; least postorbital width 10.0, 9.2; least interorbital width 10.5, 10.7; breadth of braincase ?, 37.9; length of auditory bullae 17.5, 17.0.

**REMARKS:** *G. t. aequatorialis* has an average of seven white rings on the tail, and as a rule the last one or two white rings are interrupted dorsally by the black bands. The distal portion of the tail is always black. The spots on the back and sides are discreet and do not tend to fade out into the ground color. The line of spots immediately lateral to the middorsal stripe tends to coalesce posteriorly. The middorsal stripe ends at about the level of the shoulders.

The skulls are smaller than in *G. genetta senegalensis* except for the auditory bullae, which are of the same length and more inflated ventrally in *tigrina*.

*Civettictis civetta congica* Cabrera

*Civettictis civetta congica* Cabrera, Mem. Real Soc. Española Hist. Nat. Madrid, vol. 16, p. 36, July 10, 1929. (Niapu, Belgian Congo.)

**SPECIMENS EXAMINED:** Two, from: Torit, 1; Obbo, 1.

**REMARKS:** The above specimens do not exactly agree with the description of *congica* but more closely approximate that subspecies than any of the other named kinds.

## Subfamily Herpestinae

*Herpestes sanguineus sanguineus* Rüppell

*Herpestes sanguineus* Rüppell, Neue Wirbelthiere, zu der Fauna von Abyssinien gehörig, Säugethiere, vol. 1, p. 27, 1835. (Kordofan.)

**SPECIMENS EXAMINED:** Thirteen, from: Niurmya, 1 (BM); Kulme, Wadi Aribi, 3 (BM); Mebit, near El Fasher, 1 (BM); south-eastern Jebel Marra, 1 (BM); 35 miles north of El Fasher, 1 (BM); central Jebel Marra, 4 (BM); Darfur, 1 (BM); Torit, 1.



MEASUREMENTS: An adult male from the Jebel Marra measures as follows: Length of head and body 290; length of tail 275; length of hind foot 60; length of ear 25; greatest length of skull 62.9; condyloincisive length 60.9; greatest width across zygomatic arches 29.0; least postorbital width 13.8; least interorbital width 10.7; breadth of braincase 25.1; length of auditory bullae 14.3.

REMARKS: The mongoose here referred to *Herpestes* has long been known by the generic name *Myonax*. I am following the usage of Ellerman, Morrison-Scott, and Hayman (1953) in referring this species to the genus *Herpestes*.

*Dologale dybowskii* (Pousargues)

*Crossarchus dybowskii* Pousargues, Bull. Soc. Zool. France, vol. 18, p. 51, 1893; Nouv. Arch. Mus. Hist. Nat., Paris, vol. 3, No. 6, p. 121, 1894. (Ubangi, Belgian Congo.)

*Herpestes nigripes* Kershaw, Ann. Mag. Nat. Hist., ser. 9, vol. 13, p. 22, January 1924. (Moru District, Mongalla.)

SPECIMENS EXAMINED: Four, from: Khartoum, 1 (BM); Issore, Imatong Mountains, 1 (BM); Rejaf District, Mongalla Province, 1 (BM); Torit, 1.

MEASUREMENTS: A young adult female from Rejaf District measures as follows: Length of head and body 215; length of tail 164; length of hind foot 54; length of ear 21; greatest length of skull 53.7; condyloincisive length 51.8; greatest width across zygomatic arches 27.7; least postorbital width 12.6; least interorbital width 9.5; breadth of braincase 25.5; length of auditory bullae 12.0.

REMARKS: The specimen from Torit was obtained in savanna country. Apparently little is known concerning the habits or distribution of this small mongoose.

*Mungos mungo gothnehi* (Heuglin and Fitzinger)

*Herpestes gothnehi* Heuglin and Fitzinger, Sitzb. K. Akad. Wiss. Wien, Math.-Nat., vol. 54, sec. 1, p. 560, 1866.

*Herpestes leucos ethicus* Heuglin and Fitzinger, Sitzb. K. Akad. Wiss. Wien, Math.-Nat., vol. 54, sec. 1, p. 561 1866. (Junction of the Sobat and Bahr-el-Abiad.)

SPECIMENS EXAMINED: Four, from: White Nile, 2 (BM); Rejaf District, 1 (BM); Torit, 1.

REMARKS: Allen (1939, p. 218) lists *Herpestes adailensis* Heuglin 1861 as a synonym of *gothnehi*. This is apparently in error and *adailensis* should be referred to *M. m. zebra* Rüppell, 1835, from the lowlands of Kulla and Massawa, Eritrea. In Petermann's Geographische Mittheilungen, (1861, p. 17), Heuglin states that the back is striped as in *H. zebra* and cites the "Adail-Küste unfern Tedjura" as the locality from which he examined an old male. In view of the

locality and Heuglin's description, the name *adailensis* should therefore be placed in synonymy as mentioned above.

No measurements are available for any of the specimens listed above since they are all immature.

***Ichneumia albicauda albicauda* (G. Cuvier)**

*Herpestes albicaudus* G. Cuvier, Regne animal, ed. 2, vol. 1, p. 158, 1829. (Senegal.)

*Herpestes leucurus* Hemprich and Ehrenberg, Symbolae physicae, Mammalia, dec. 2, folio h, i, k, pl. 12, September 1832. (Dongola.)

*Ichneumia albescens* I. Geoffroy, in Mag. de Zool., Mammalia, p. 16. 1839. (Sennaar.)

*Ichneumia abu-wudan* Fitzinger and Heuglin, Sitzb. K. Akad. Wiss. Wien, Math.-Nat., vol. 54, sec. 1, p. 561, 1866. (Berbera, Somaliland.)

**SPECIMENS EXAMINED:** Thirty, from: Roseires, 3 (BM); Soba, 2 (BM); Shereik, 2 (BM); Merowe, 2 (BM); Kerma, 1 (BM); Shendy, 5 (BM); Nagichot, 1 (BM); Bor, 2 (BM); Moru District, 1 (BM); Ayod, 1 (BM); Singa, 1 (BM); Chak Chak, 3 (BM); Juba, 1 (BM); Malek, 1 (BM); Torit, 3 (1 MCZ); Ikoto, 1.

**MEASUREMENTS:** External measurements of an adult male and an adult female from Shereik, are, respectively, as follows: Length of head and body 467, 470; length of tail 354, 430; length of hind foot 98, 103; length of ear 31, 36. Cranial measurements of an adult male from Shereik and an adult female from Soba, are respectively: Greatest length of skull 91.6, 97.2; condyloincisive length 89.6, 94.5; greatest width across zygomatic arches 46.0, 50.8; least postorbital width ?, 18.5; least interorbital width ?, 19.6; breadth of braincase 32.5, 31.6; length of auditory bullae 18.3, 18.4.

**REMARKS:** The white-tailed mongooses have a melanistic phase which makes the common name seem rather absurd. These melanistic specimens have lost the white tail tip, either completely or in part. There seems always to be present some white, which occurs only at the base of the hairs, while the tips of the same hairs in the melanistic phase are black.

Melanism does not seem to be an age character since white and black tails occur at the same age levels.

**Family HYAENIDAE**

**Subfamily Protelinae**

***Proteles cristatus pallidior* Cabrera**

*Proteles cristatus pallidior* Cabrera, Ann. Mag. Nat. Hist., ser. 8, vol. 6, p. 464, November 1910. (Suakin.)

**SPECIMENS EXAMINED:** Four, all in BM, from Suakin.

**MEASUREMENTS:** Cranial measurements of an adult male and an adult female from Suakin are, respectively, as follows: Greatest length

of skull 133, 132.7; condyloincisive length 130.8, 133.5; greatest width across zygomatic arches 77.6, 78.2; least interorbital width 28.5, 29.7; width of rostrum at level of canines 37.8, 39.4; width of palate at level of last molars 42.0, 42.7.

REMARKS: The skull of the aard wolf is small and the muzzle is quite blunt. The premolars and molars are reduced to mere pegs and the toothrows are virtually parallel. By these means it may be distinguished from the genus *Hyaena* which it resembles externally. However, the ears are longer, the legs are shorter, and in old animals the mane reaches farther posteriorly than in *Hyaena*.

### Subfamily Hyaeninae

#### *Crocuta crocuta fortis* J. A. Allen

*Crocuta crocuta fortis* J. A. Allen, Bull. Amer. Mus. Nat. Hist., vol. 47, p. 214, Apr. 11, 1924. (Faradje, Belgian Congo.)

SPECIMENS EXAMINED: Five, all in BM, from: Kulme, Wadi Aribo, 1; Meshra Zeraf, 1; northern Darfur, 1; Bahr Zeraf, 1; Kaka, 1.

MEASUREMENTS: Cranial measurements of an adult male from Kaka and an adult female from Meshra Zeraf are, respectively, as follows: Greatest length of skull 257, 273; condyloincisive length 240, 250; greatest width across zygomatic arches 152, 176; least interorbital width 54.5, 64.0; greatest length of fourth upper premolar 36.6, 37.3.

REMARKS: The spotted hyaena may be distinguished readily from the striped hyaena by the pattern of the pelage. In addition, the skulls are separable by means of the larger and more inflated auditory bullae, the wider posterior choanae, and the much larger and wider upper fourth premolar.

#### *Hyaena hyaena dubbah* Meyer

*Hyaena dubbah* F. A. A. Meyer, Systematisch-Summarisch Uebersicht der neuesten zoologischen Entdeckungen in Neu-Holland und Afrika, p. 94, 1793. (Based on Bruce's Travels to discover source of Nile, 1791.) (Atbara.)

*Canis hyaenomelas* Desmarest, Encyclopaedia Méthodique, Mammalogie, p. 215, 1820. (Atbara.)

*Hyaena dubia* Schinz, Das Thierreich . . . von Cuvier, vol. 4, p. 509, 1825. (Dongola.)

*Hyaena hienomelas* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 53, 1900. (Atbara.)

SPECIMENS EXAMINED: Four, all in BM, from: 100 miles west of Nahud, 1; foothills of southern Jebel Marra, 1; Sudan (no precise locality), 1; Kulme, Wadi Aribo, 1.

MEASUREMENTS: An adult male from southern Jebel Marra measures as follows: Length of head and body 1169; length of tail 332;

length of hind foot 209; length of ear 146; greatest length of skull 230; condyloincisive length 212; greatest width across zygomatic arches 150; least interorbital width 45.5; length of upper fourth premolar 31.2.

## Family FELIDAE

### Subfamily Felinae

#### *Felis caracal nubicus* J. B. Fischer

*Felis caracal*  $\gamma$  *nubicus* J. B. Fischer, Synopsis mammalium, p. 210, 1829. (Nubia, implied.)

SPECIMEN EXAMINED: One, in BM, from Suakin.

MEASUREMENTS: Cranial measurements of the unsexed specimen from Suakin are as follows: Greatest width across zygomatic arches 72.0; least postorbital width 29.0; least interorbital width 19.5; breadth across  $P^4$ - $P^4$  44.7; length of  $P^4$  15.7.

REMARKS: The generic name of the caracals has been in constant flux between *Lynx* and *Felis*. Without attempting to arbitrate, I am following the usage of Pocock (1917) and of Ellerman and Morrison-Scott (1951).

Even though only one specimen has been examined, it would seem that the caracal would range over most of the Sudan in rocky and brushy situations.

#### *Felis libyca libyca* Forster

##### FIGURE 9,b

*Felis libyca* Forster, in Buffon, Naturgeschichte der Vierfüssigen Thiere . . . , vol. 6, p. 313, 1780. (Gafsa, Tunisia.)

*Felis maniculata* Temminck, Monographies de mammalogie, vol. 1, p. 128, 1824. (Ambukol.)

*Felis ruppelii* (sic) Schinz, Das Thierreich . . . von Cuvier, vol. 4, p. 509, 1824. (Dongola.)

*Felis libyca lowei* Pocock, Proc. Zool. Soc. London, vol. 114, p. 68, 1944. (Jebel Marra, 4,000 feet.)

*Felis libyca lynesii* Pocock, Proc. Zool. Soc. London, vol. 114, p. 68, 1944. (35 miles north of El Fasher.)

(Other synonyms extralimital to the Sudan.)

SPECIMENS EXAMINED: Seven, all in BM, from: *Dueim*, 1; Sennaar, 1; Shendy, 1; *Tamai Plains, near Suakin*, 1; Suakin, 3.

MEASUREMENTS: An adult male from Shendy measures as follows: Length of head and body 490; length of tail 340; length of hind foot 132; length of ear 54; greatest length of skull 108.6; condyloincisive length 100.3; greatest width across zygomatic arches 66.6; least

postorbital width 30.0; least interorbital width 17.7; length of P<sup>4</sup> 12.2.

REMARKS: The specimens here referred to the subspecies *libyca* were referred to *ocreata* by Allen (1939). However, Pocock (1951) restricted *ocreata* to Abyssinia and referred the northern and eastern Sudanese specimens to *libyca*. It is true that the small cats from Abyssinia are darker in color than the specimens from the Red Sea coast and from near the Nile. These latter specimens, though, are virtually indistinguishable, both in color and cranially, from animals from Tunisia. I am therefore following Pocock (1951) in assigning the northeastern Sudanese specimens to the nominate race.

The two subspecies named by Pocock (1944, p. 68), *lynesi* and *lowei*, are in no measure different than animals assigned to the nominate race. The type of *lynesi* is a young adult with the characteristic bright colors of animals of like age from the range of *libyca*. The type of *lowei* is, so far as I can tell, identical with the specimen from Shendy which has been referred to *libyca*.

I feel that it is better to express *lynesi* and *lowei* as synonyms of *libyca* until such time as more material has been made available and the degree of variation has been completely worked out.

***Felis libyca ugandae* Schwann**

FIGURE 9,b

*Felis ocreata ugandae* Schwann, Ann. Mag. Nat. Hist., ser. 7, vol. 13, p. 424, June, 1904. (Mulema, Uganda.)

SPECIMENS EXAMINED: Two, both in BM, from: Juba, 1; Shubhikra, north of Omdurman, 1.

MEASUREMENTS: An adult male from Juba measures as follows: Length of head and body 556; length of tail 365; length of hind foot 139; length of ear 56; greatest length of skull 103.0; condyloincisive length 93.1; greatest width across zygomatic arches 72.3; least post-orbital width 30.7; least interorbital width 19.0; length of P<sup>4</sup> 11.2.

REMARKS: These two specimens agree in color with animals from Uganda in that they are much darker than specimens from farther east and north.

***Felis serval phillipsi* G. M. Allen**

*Felis capensis phillipsi* G. M. Allen, Bull. Mus. Comp. Zool., vol. 58, p. 337, July 1914. (El Garef, Blue Nile.)

SPECIMENS EXAMINED: Ten, from: White Nile, 1 (BM); Khartoum, 1 (BM); Nagichot, 1 (BM); Bahr-el-Ghazal, 1 (BM); near Juba, 1 (BM); Kulme, Wadi Aribo, 1 (BM); El Garef, 1 (MCZ); Torit, 1; Terangole, 20 miles east of Torit, 2 (1 MCZ).

MEASUREMENTS: The type, an adult male, measures as follows: Length of head and body 792; length of tail 290; length of hind foot

185; length of ear 90; greatest width across zygomatic arches 78.9; least postorbital width 31.9; least interorbital width 21.7.

REMARKS: There is a considerable amount of cranial variation shown by the above specimens. This variation consists of differences in size and shape of the teeth, particularly the carnassial; the width of the posterior choanae; and the size and degree of inflation of the auditory bullae. The specimen from Kulme differs from all of the other specimens in the strikingly different tone of the ground color of the pelage. This color is grayish instead of buffy and the black spots are markedly more discreet. It is probable that this specimen is wrongly referred but in comparison to other named kinds of servals it is closer to *phillipsi* than to any other.

***Panthera pardus chui* (Heller)**

*Felis pardus chui* Heller, Smithsonian Misc. Coll., vol. 61, No. 19, p. 6, November 1913. (Gondokoro.)

SPECIMENS EXAMINED: Eight, from: near Bor, 3 (BM); near Mongalla, 1 (BM); Bor District, 1 (BM); Gondokoro, 1; Ed Dueim, 1; Khartoum, 1.

MEASUREMENTS: The type, an adult male, measures as follows: Length of head and body 1240; length of tail 840; length of hind foot 255; length of ear 90; greatest length of skull 243; greatest width across zygomatic arches 150; least interorbital width 37; length of nasals 76.

REMARKS: Hollister (1918, p. 170) listed the specimens from Ed Dueim and Khartoum as the nominate race. On closer examination, however, these two skins only seem to fall within the range of variation of *chui* to which they are referred.

***Panthera leo leo* (Linnaeus)**

*Felis leo* Linnaeus, Systema naturae, ed. 10, vol. 1, p. 41, 1758. ("Africa," fixed as Constantine, Algeria, by J. A. Allen, 1924, p. 222.)

*Felis leo nubicus* Blainville, Osteographie . . . Mammifères . . . , Genus *Felis*, p. 58, 1843. (Nubia.)

(Other synonyms extralimital to the Sudan.)

REMARKS: No specimens of the lion from the Sudan have been examined. Hollister (1918, p. 165) lists a zoo specimen from Omdurman which has been examined but rejected owing to the faulty references to locality and to the fact that the animal has been in captivity.

The generic name *Panthera* is used following Simpson (1945) and the specific and subspecific names are following Ellerman and Morrison-Scott (1951) and Ellerman, Morrison-Scott, and Hayman (1953).

*Acinonyx jubatus soemmeringii* (Fitzinger)

*Cynailurus soemmeringii* Fitzinger, Sitzb. K. Akad. Wiss. Wien, Math.-Nat., vol. 17, pt. 2, p. 245, 1855. (Steppes of Kababish, south of Bajuda Desert, Kordofan.)

*Felis megabalica* Heuglin, Leopoldina, Amtliche Organ K. Leop.-Carol. Deutsch. Akad. Naturf., vol. 4, No. 3, p. 23. May, 1863. (West bank of Bahr-el-Abiad.)

*Acinonyx wagneri* Hilzheimer, Sitzb. Ges. Naturf. Freunde, Berlin, p. 285, 1913. (Kordofan.)

SPECIMEN EXAMINED: One, from Ed Ducim.

REMARKS: The specimen above is the only specimen available to me from the Sudan. It is a skin without a skull and external measurements.

## Order TUBULIDENTATA

## Family ORYCTEROPODIDAE

Genus *Orycteropus* Geoffroy

No specimens of the aardvark have been examined. Two subspecies, *Orycteropus afer aethiopicus* Sundevall from the Bahr-el-Abiad and *Orycteropus afer kordofanicus* Rothschild from Kordofan have been described.

Apparently big game hunters do not call these animals game, and the mammal collector is more interested in the rodents, insectivores, and bats. Thus, extremely few specimens of aardvarks are known in museum collections.

## Order PROBOSCIDEA

## Family ELEPHANTIDAE

## Subfamily Elephantinae

*Loxodonta africana oxyotis* (Matschie)

*Elephas (Loxodonta) oxyotis* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 196, 1900. (Upper Atbara River.)

SPECIMENS EXAMINED: One, in BM, from White Nile.

REMARKS: The elephant was apparently widespread in the southern half of the Sudan in the past. However, at the present time populations seem to be quite local, in some places disappearing but in other places increasing in numbers.

For a resumé of the elephant in the Sudan see in the section on "The Elephant in the Sudan" by the late Maj. W. Barker, pages 68-79 in "The Elephant in East Central Africa, a Monograph," published by Rowland Ward, Ltd., 1953.

## Order HYRACOIDEA

## Family PROCAVIIDAE

*Heterohyrax brucei hoogstraali*, new subspecies

TYPE: CNHM No. 66868, adult female, skin and skull, from Imurok, Torit District, Equatoria Province, Anglo-Egyptian Sudan. Obtained Feb. 1, 1950, by Harry Hoogstraal, original No. 5109.

SPECIMENS EXAMINED: Fifteen, from: Logire, 1; Imurok, 6; Imatong Mountains, 2; Sunnat, 2; Torit, 1; Nimule, 3.

DIAGNOSIS: Pure color on hairs of upperparts near Avellaneous. Individual hairs banded plumbeous basally, Cinnamon Drab (which does not show externally), black, Avellaneous, and finely tipped with black, thus presenting a "salt and pepper" or "agouti" pattern. Dorsal color shading gradually over sides into the grayish white of the belly. White hairs on throat, midpectoral region, and inguinal region white to base. Top of head darker than rest of dorsal color. Dorsal spot whitish, large, and bordered by darker color than rest of dorsal coloration. Skull robust, upper cheekteeth light in build, auditory bullae small, rostrum narrow, nasals short.

MEASUREMENTS OF THE TYPE SPECIMEN: Length of head and body 452; length of hind foot 69; length of ear 35; condyloincisive length of skull 83.2; crown length of upper toothrow 30.9; least postorbital width 24.5; least interorbital width 47.5; length of nasals 20.4.

COMPARISONS: From *H. b. kempfi*, *H. b. hoogstraali* differs in somewhat darker color, smaller skull, shorter upper toothrow, and a markedly narrower rostrum.

*H. b. hoogstraali* differs from the type of *H. b. bakeri* in darker dorsal color, dorsal spot whiter, rostrum narrower, upper cheekteeth smaller, and upper toothrow somewhat shorter.

No specimens or measurements of *H. b. thomasi* have been available, but from the original description it seems that *H. b. hoogstraali* is darker and possibly larger.

REMARKS: Hollister (1924, p. 142) listed the specimens from Nimule as *Heterohyrax brucei bakeri*. However, when compared with the specimens from the Torit area and with the type of *bakeri*, there can be no question as to their affinity.

The Nimule specimens differ from *bakeri* in exactly the same degree as the Torit material. There is no evidence of intergradation in any of the specimens examined.



*Procavia habessinica burtonii* (Gray)

FIGURE 9,c

*Hyrax burtonii* Gray, Ann. Mag. Nat. Hist., ser. 4, No. 1, p. 43, January 1868.  
("Egypt.")

*Hyrax dongolanus* Blanford, Proc. Zool. Soc. London (1869), p. 642, April 1870.  
(Dongola.)

SPECIMEN EXAMINED: Only the type, in BM.

MEASUREMENTS: Cranial measurements of the type, an unsexed young adult, are as follows: Crown length of upper toothrow 36.2; least interorbital width 21.7; least postorbital width 23.5; greatest width across zygomatic arches 54.0; length of nasals 22.8.

REMARKS: In both *burtonii* and *butleri* the dorsal spot is quite small and yellowish. The former is markedly lighter in general over-all color than is *butleri*. That this is not due to fading is apparent from the original description in which Gray comments on the paleness of the color of the specimens obtained by Burton.

*Procavia habessinica butleri* Wroughton

FIGURE 9,c

*Procavia butleri* Wroughton, Ann. Mag. Nat. Hist., ser. 8, vol. 8, p. 461, October 1911. (Jebel Fazogli, Blue Nile at Abyssinian border.)

SPECIMENS EXAMINED: Five, all in BM, from: Gebel Ain, 3; Jebel Fazogli, 1; *Wadi Feroni*, 1.

MEASUREMENTS: The cranial measurements of the type specimen, an adult male from Jebel Fazogli, are as follows: Condylolincisive length 92.3; crown length of upper toothrow 38.5; least interorbital width 22.1; least postorbital width 25.6; greatest width across zygomatic arches 54.5; length of nasals 25.0.

REMARKS: There is a decided black cap on the head in *butleri*. This black color continues caudad to just behind the shoulders as a rather broad stripe. This striped effect has not been seen on any of the other specimens of *Procavia* from the Sudan.

Ellerman and Morrison-Scott (1951, p. 334) have arranged all of the *Procavia* of Africa as subspecies of the single species *capensis*. Hahn (1934), in a revision of the family, recognized separate species. Certainly, in the Sudan, two species can be distinguished. They are *habessinica* and *ruficeps*. The former may be recognized by its markedly larger cheekteeth, the larger skull, the lack of inflation over the frontals, and the laterally curved upper incisors. Since, in specimens examined from the Sudan, these features remained constant, I prefer to recognize the two species as discreet from *capensis*.

*Procavia habessinica slatini* Sassi

FIGURE 9,c

*Procavia slatini* Sassi, Sitzb. K. Akad. Wiss. Wien, Math.-Nat., vol. 115, sect. 1, pt. 6, p. 1002, June 1906. (Hills on the White Nile, south of Gondokoro, lat. 5° N.)

SPECIMENS EXAMINED: Five, all in BM, from: *Moru district*, 2; *Rejaf*, 1; *Uvolo*, 1; *Juba*, 1.

MEASUREMENTS: A young adult female from the Moru district measures as follows: length of head and body 498; length of hind foot 67; length of ear 30; condyloincisive length of skull 86.4; crown length of upper tooththrow 40.7; least postorbital width 21.4; least interorbital width 24.4; greatest width across zygomatic arches 49.6; length of nasals 22.4.

REMARKS: In general, *slatini* is the darkest of the *Procavia* to be found in the Sudan. The dorsal spot, unlike that in the next darkest kind, *marrensis*, is quite noticeable but is still not so pronounced as in either *ebneri* or *ruficeps*.

The skulls of *slatini* differ from *P. h. butleri* only in the smaller size of the auditory bullae, the shorter nasals, and the narrower inter-orbitum.

G. M. Allen (1939, p. 452) listed *slatini* as a subspecies of *ruficeps*. I feel, after a close study of the specimens in the British Museum, that these animals are referable to *Procavia habessinica* because of the lack of frontal inflation, the massiveness of the cheekteeth, and the lateral curving of the upper incisors.

*Procavia ruficeps ebneri* Wettstein

FIGURE 9,d

*Procavia (Procavia) ebneri* Wettstein, Anz. K. Akad. Wiss. Wien, Math.-Nat., vol. 53, p. 162, 1916. (Talodi, Kordofan.)

SPECIMENS EXAMINED: Seven, all in BM, from: *Agageh Wells*, 5; *Kaga Hills*, 1; *Nuba Mountains*, 1.

MEASUREMENTS: An adult female from Agageh Wells measures as follows: Length of head and body 473; length of hind foot 55; length of ear 27; condyloincisive length of skull 84.1; crown length of upper tooththrow 33.4; least postorbital width 20.0; least interorbital width 24.7; greatest width across zygomatic arches 48.8; length of nasals 21.2.

REMARKS: These animals are darker in color than *ruficeps* but not so dark as in typical *marrensis*. The dorsal spot is large and orange colored, but not so large as in *ruficeps* and not so obscured as in *marrensis*.

Cranially, *ebneri* differs from *ruficeps* in that the frontals are not so inflated, the rostrum is narrower, the posterior choanae are not so flaring, and the auditory bullae are larger.

***Procavia ruficeps marrensis* Thomas and Hinton**

FIGURE 9,d

*Procavia ruficeps marrensis* Thomas and Hinton, Proc. Zool. Soc. London, p. 271, July 6, 1923. (Central part of Jebel Marra, Darfur.)

SPECIMENS EXAMINED: Twenty-three, all in BM, from: *Niurmya*, 5; foothills of southern Jebel Marra, 2; 60 miles northeast of El Fasher, 1; *Jebel Owi*, 3; *central Jebel Marra*, 1; Kulme, Wadi Aribo, 2; Zalingei, 5; *35 miles northeast of El Fasher*, 3; *Jebel Meidob*, 1.

MEASUREMENTS: An adult male and an adult female from *Niurmya* measure, respectively, as follows: Length of head and body 508, 534; length of hind foot 70, 67; length of ear 27, 29; condyloincisive length of skull 86.6, 90.0; crown length of upper toothrow 35.2, 34.5; least interorbital width 22.7, 24.1; least postorbital width 25.8, 24.6; greatest width across zygomatic arches 53.2, 53.1; length of nasals 21.7, 25.7.

REMARKS: The dassies from the Jebel Marra are quite dark in general color. The dorsal spot, or gland, is virtually indistinguishable. This spot, when visible, is orange colored as in other members of the species.

Specimens from the vicinity of El Fasher and Zalingei are noticeably paler in color than are the ones from the Jebel Marra. The dorsal gland is more pronounced but not so large as in *ruficeps*. I consider these animals as intergrades between *ruficeps* and *marrensis* but referable to the latter because of their generally darker tone than is found in *ruficeps*. In cranial features they more nearly resemble *marrensis*.

The skull is larger, the rostrum is wider, the ventral foramen enclosed by the zygoma is larger, the upper toothrow is generally longer, the auditory bullae are larger, and the posterior choanae are less flaring in *marrensis* than they are in *ebneri*.

***Procavia ruficeps ruficeps* (Hemprich and Ehrenberg)**

FIGURE 9,d

*Hyrax ruficeps* Hemprich and Ehrenberg, Symbolae physicae, Zool., Mamm., dec. 1, folio h, pl. 2, August 1832. (Dongola.)

SPECIMENS EXAMINED: Thirteen, all in BM, from: Shabluka Hills, 11; Khor Arbat, 1; Sinkat, 1.

MEASUREMENTS: Two adult males from Shabluka Hills measure, respectively as follows: Length of head and body 460, 470; length of hind foot 66, 67; length of ear 32, 30; condyloincisive length of skull

80.9, 81.8; crown length of upper toothrow 35.3, 34.4; least interorbital width 21.8, 25.2; least postorbital width 25.8, 26.0; greatest width across zygomatic arches 47.3, 51.8; length of nasals 20.0, 21.0.

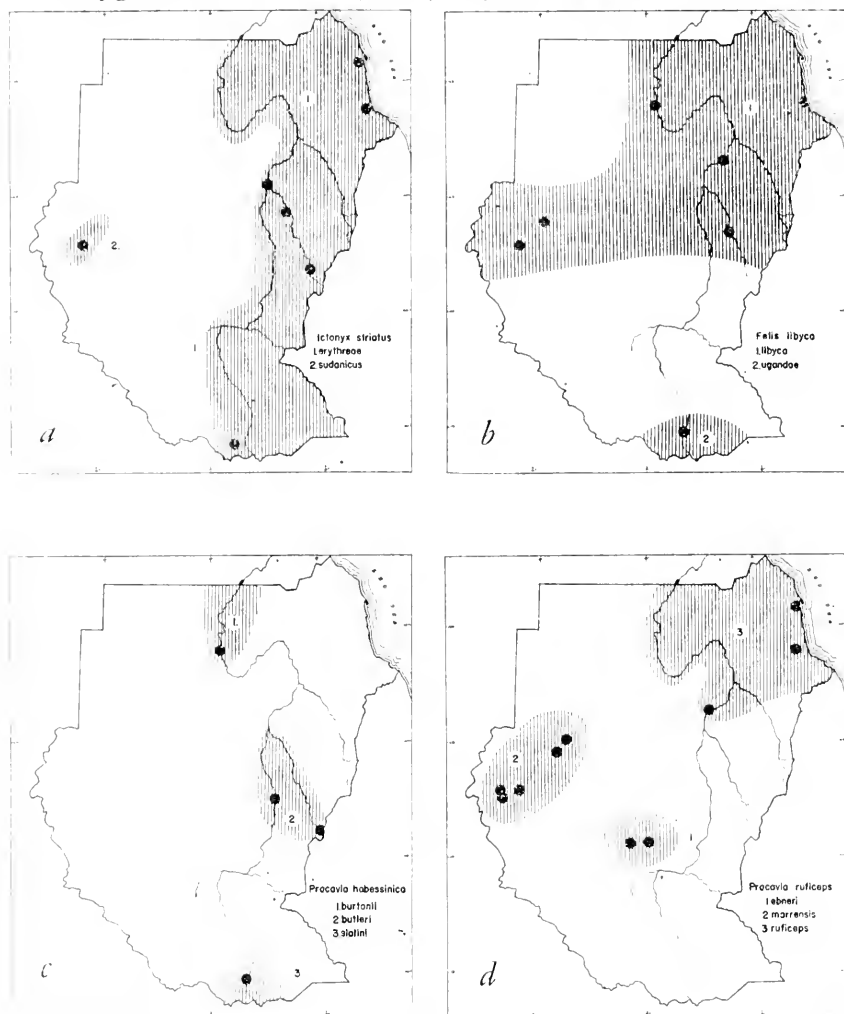


FIGURE 9.—Distribution of *Ictonyx*, *Felis*, and *Procavia* in the Anglo-Egyptian Sudan. (Scale: 1 inch=400 miles.)

REMARKS: These specimens are pale gray in general over-all color and have a rather large orange colored dorsal spot.

The nominate race may be differentiated from *marrensis* by somewhat smaller size, posterior choanae more flaring, auditory bullae

smaller, ventral foramen enclosed by the zygoma smaller, and frontals more inflated.

The amount of variation in certain aspects of the cranium is rather great, as may be seen from the measurements of two males of like age (so far as could be determined by the degree of wear on the last molar).

## Order PERISSODACTYLA

### Family EQUIDAE

#### Subfamily Equinae

##### *Equus asinus africanus* (Fitzinger)

*Asinus africanus* Fitzinger, Wissenschaftlich-populäre Naturgeschichte der Säugthiere . . . vol. 3, p. 667, 1857. (Nubia.)

REMARKS: No specimens of this animal have been seen. It is now considered to be extinct in its former range in Nubia.

##### *Equus asinus dianaë* (Dollman)

*Asinus asinus dianaë* Dollman, Proc. Linn. Soc. London (1934-35), 147th session, p. 132, May 9, 1935. (Wadi Hafta, lat. 17°43' N., long. 37°36' E.)

SPECIMEN EXAMINED: One, in BM, from the type locality.

REMARKS: From the appearance of the skin of this ass, contrasted to a skin of *somalicus* and a color interpretation from the literature of *africanus*, it would seem to be an intergrade. Certainly the geographic area from which it comes places it between the two previously named kinds.

Owing to the fact that so few specimens are known of *dianaë*, and apparently no specimens of *africanus*, I feel it is best to leave the name *dianaë* as expressing a different population but which may be shown later to be the same as one of the previously named kinds adjacent to its type locality.

##### *Equus burchellii böhmi* Matschie

*Equus böhmi* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 131, 1892. (Pangani River, Tanganyika.)

REMARKS: No specimens of this zebra have been examined. Hamilton (1920, p. 346) cites observations of this animal from the Bor District but comments that they are probably stragglers during the dry season. The same author says that lat. 7°30' N. is probably the extreme northern limit of the range.

## Family RHINOCEROTIDAE

*Ceratotherium simum cottoni* (Lydekker)

*Rhinoceros simus cottoni* Lydekker, The Field (London), vol. 111, p. 319, Feb. 22, 1908. (Lado Enclave.)

SPECIMENS EXAMINED: Four, from: Bahr-el-Ghazal District, 3; Uganda-Lado-Sudan boundary, 1 (BM).

REMARKS: The white, or square lipped, rhinoceros probably ranges only as far north as the swamps on the west bank of the Nile.

For further information concerning the white rhinoceros see E. Heller's article, "The White Rhinoceros" (Smithsonian Misc. Coll., vol. 61, No. 1, pp. 1-77, 1913).

*Diceros bicornis somaliensis* (Potocki)

*Rhinoceros brucii* Lesson, Nouveau tableau du règne animal . . . Mammifères, p. 159, 1842. (Nomen nudum.)

*Rhinoceros bicornis somaliensis* Potocki, Sport in Somaliland, p. 82, 1900. (Ogaden, Ethiopia.)

SPECIMENS EXAMINED: Two, both in BM, from: Jubaland, 1; Sennaar, lat. 12° to 13° N., 1.

REMARKS: Mr. Harry Hoogstraal informs me that the black rhino is still to be found in certain low lying areas between Juba and Torit.

## Order ARTIODACTYLA

## Family SUIDAE

## Subfamily Suinae

*Sus scrofa sennaariensis* Gray

*Sus sennaariensis* Gray, Proc. Zool. Soc. London, p. 32, May 1868. (Sennaar, Kordofan, and Sudan).

SPECIMENS EXAMINED: None.

REMARKS: This subspecies of pig is being included in this report on the basis of observations of feral pigs in several parts of the Sudan.

*Phacochoerus aethiopicus bufo* Heller

*Phacochoerus africanus bufo* Heller, Smithsonian Misc. Coll., vol. 61, No. 22, p. 2, Jan. 26, 1914. (Rhino Camp, Lado Enclave.)

*Phacochoerus barkeri* Rothschild, Ann. Mag. Nat. Hist., ser. 9, vol. 6, p. 416, October 1920. (Southwest of Bahr-el-Ghazal.)

SPECIMENS EXAMINED: Five, from: Kulme, Wadi Aribo, 2 (BM); southwestern Bahr-el-Ghazal, 1 (BM); Torit, 2.

REMARKS: *P. a. bufo* may be distinguished from *P. a. aeliani* from British East Africa and Ethiopia by the wider upper molars, less inflated auditory bullae, less concavity of the dorsal surface of the skull between the orbits, and the flatter nasals.

The skull available from Torit is of an immature female of the same age as the type of *P. a. bufo*. In all characters this skull agrees with the type and differs from *P. a. aeliani* as above. These characters are not sexual or age variations since they differ to the same degree in animals of comparable age and sex of *P. a. aeliani* from British East Africa.

The skull of *P. barkeri* differs from *P. a. aeliani* in exactly the same degree and quality as do skulls of *P. a. bufo*. Since Rothschild's name is antedated by *bufo* and since I can detect no differences between *bufo* and *barkeri* I am treating the latter as a synonym of the former.

### Family HIPPOPOTAMIDAE

#### *Hippopotamus amphibius amphibius* Linnaeus

*Hippopotamus amphibius* Linnaeus, Systema naturae, ed. 10, vol. 1, p. 74, 1758.

(Nile River, Egypt.)

(Other synonyms extralimital to the Sudan.)

SPECIMENS EXAMINED: Two, both in BM, from White Nile.

REMARKS: The hippopotamus was formerly abundant throughout the Nile drainage. It is now extinct north of Khartoum and reduced in numbers throughout the rest of the drainage system except in the great lakes to the south.

### Family GIRAFFIDAE

#### *Giraffa camelopardalis* Linnaeus

REMARKS: Two subspecies of giraffes are supposed to exist in the Sudan. The northern and eastern one is *Giraffa camelopardalis camelopardalis* Linnaeus, 1758, with the type locality given as "Ethiopia and Sennar," actually from a captive animal in Cairo, Egypt, assumed to be from the Abyssinian, or Kassala, side of Upper Nubia. The western and southern subspecies has been described as *Giraffa camelopardalis antiquorum* Jardine, 1835, with the type locality stated as "Senaar and Darfour." Other names have been proposed but are now regarded as synonyms of the earlier *camelopardalis* and *antiquorum*.

As may be noted, both subspecies share the type locality of Sennaar. This seems highly unreasonable but without a detailed study of the genus it seems that the problem will not be solved. Only two speci-

mens have been available to me from the Sudan. These are from the White Nile and from Fashoda, both presumably within the range of the nominate form.

Apparently the giraffe is becoming more and more restricted in range and numbers in all parts of the Sudan.

## Family BOVIDAE

### Subfamily Bovinae

#### *Tragelaphus scriptus bor* Heuglin

##### FIGURE 10,a

*Tragelaphus bor* Heuglin, Reise in Nordost-Afrika, vol. 2, p. 122, 1877. (Req marshes and Bongo, Bahr-el-Ghazal.)

SPECIMENS EXAMINED: Nine, from: Wau, Jur River, 1 (BM); 80 miles northeast of Lado, lat.  $4^{\circ}50'$  N., long.  $32^{\circ}55'$  E., 1 (BM); 100 miles northeast of Bor, 4 (BM); *Lokila*, 1 (BM); Nimule, 1; 60 miles north of Nimule, 1.

REMARKS: The bushbucks listed here as species of the genus *Tragelaphus* were formerly considered to belong to the genera *Strepsiceros*, *Limnotragus*, and *Tragelaphus*. The two former genera are now considered subgenera. The species under the subgenus *Strepsiceros* is *strepsiceros*; for the subgenus *Limnotragus* the species is *spekii*; and for the subgenus *Tragelaphus* the species is *scriptus*.

#### *Tragelaphus scriptus decula* (Rüppell)

##### FIGURE 10,a

*Antilope decula* Rüppell, Neue Wirbelthiere zu der Fauna von Abyssinien gehörig, Säugethiere, p. 11, pl. 4, 1835. (Northwest slope of the highlands about Dembea Lake and the Kulla, Ethiopia.)

SPECIMEN EXAMINED: One, in BM, from Salam River on Upper Atbara River.

#### *Tragelaphus scriptus dodingae* Matschie

##### FIGURE 10,a

*Tragelaphus cottoni dodingae* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 556, December 1912. (Kedef Valley, western foothills of Dodinga (=Didinga) Range, east-northeast of Dufilé.)

*Tragelaphus scriptus barkeri* J. D. Millais, Far away up the Nile, p. 233, 1924. Imatong Mountains.

SPECIMENS EXAMINED: Four, all in BM, from: Imatong Mountains, 3; Lomuleng, Imatong Mountains, 1.



*Tragelaphus spekii larkenii* (St. Leger)

*Limnotragus spekii larkenii* St. Leger, Ann. Mag. Nat. Hist., ser. 10, vol. 8, p. 420, October 1931. (Bahr-el-Ghazal, 50 miles south of Yambio, lat. 4°30' N., long. 28° E.)

SPECIMENS EXAMINED: Eight, all in BM, from: Diawo, 4; lat. 4°30' N., long. 28° E., south of Yambio, 2; Yambio, 1; Bahr-el-Ghazal, 1

*Tragelaphus strepsiceros chora* (Cretzschmar)

*Antilope chora* Cretzschmar, in Rüppell, Atlas zu der Reise im nördlichen Afrika von Rüppell, vol. 1, Säugethiere, p. 22, 1826. (Eastern Sudan.)

*Antilope tendal* Cretzschmar, in Rüppell, Atlas zu der Reise im nördlichen Afrika von Rüppell, pt. 1, Säugethiere, p. 22, 1826. (Deserts of "Sinerie" to Ambukol.) (Stated by Lydekker and Blaine, Catalogue of the Ungulate Mammals in the British Museum (Natural History), vol. 3, p. 202, 1914, perhaps to be *Addax nasomaculatus*.)

*Strepsiceros abyssinicus* Fitzinger, Sitzb. K. Akad. Wiss. Wien, Math.-Nat., vol. 59, sect. 1, p. 176, 1869. (Abyssinia, Somaliland, to Kordofan.)

SPECIMENS EXAMINED: Two, both in BM, from: Blue Nile, 1; Eirerib, 1.

*Taurotragus derbianus gigas* (Heuglin)

*Boselaphus gigas* Heuglin, Nova Acta Acad. Caes. Leop.-Carol., Jena, vol. 30, No. 2, p. 19, pl. 1, fig. 2, 1863. (West of the Upper Nile, lat. 7° N., Bahr-el-Ghazal.)

SPECIMENS EXAMINED: Five, from: Khor Gorman, 30 miles west of Rumbek, 1 (BM); Bahr-el-Ghazal, 1 (BM); 25 miles west of Rejaf, 3.

REMARKS: The giant eland of southwestern Sudan apparently is not a common big game species. Its affinities are definitely with the West African species *derbianus* and not with the eastern and southern African species *oryx*.

*Syncerus caffer aequinoctialis* (Blyth)

*B[ubalus] caffer*, var. *aequinoctialis* Blyth, Proc. Zool. Soc. London, p. 372, 1866. (White Nile.)

*Bubalus azrakensis* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 169, 1906. (Roseires.)

*Bubalus solwayi* Matschie, Deutsche Jäger-zeitung, vol. 57, No. 7, p. 104, 1911. (Mongalla.)

SPECIMENS EXAMINED: None.

REMARKS: The buffalo is recorded here on the basis of sight records by Hoogstraal in the southern Sudan.

## Subfamily Cephalophinae

*Cephalophus caerulus aequatorialis* Matschie

FIGURE 10,b

*Cephalophus* (sic) *aequatorialis* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 112, 1892. (Chagwe, Uganda.)

SPECIMENS EXAMINED: Three, all in BM, from: Diawo, 1; southwestern Sudan, 2.

REMARKS: The blue duiker has its main range to the south and east. It is doubtful that these animals are to be found in the Sudan out of the Congo forest extension and, in the case of *musculoides*, out of the mountain forest which is a counterpart of the British East African type of mountain habitat.

*Cephalophus caerulus musculoides* Heller

FIGURE 10,b

*Cephalophus monticola musculoides* Heller, Smithsonian Misc. Coll., vol. 61, No. 7, p. 9, July 31, 1913. (Kakamega Forest, British East Africa.)

SPECIMEN EXAMINED: One, from Lerua, southwestern slope of Acholi Mountains, Torit District.

REMARKS: This specimen is referred to *musculoides* only provisionally. It is a skin without a skull which was purchased from a native. Hoogstraal noted in his field catalog that these animals were very rare.

*Sylvicapra grimmia roosevelti* Heller

*Sylvicapra grimmii* (sic) *roosevelti* Heller, Smithsonian Misc. Coll., vol. 60, No. 8, p. 9, Nov. 2, 1912. (Rhino Camp, Lado Enclave.)

SPECIMENS EXAMINED: Six, from: Torit, 3; Torit area, 3.

REMARKS: All of the above specimens are immature. The oldest is a female in which M<sup>1</sup> is just erupting. While no specimens of comparable age of true *roosevelti* have been available, the characters of both skin and skull of the above animals seem to agree in detail with older specimens of *roosevelti*.

## Subfamily Hippotraginae

*Kobus defassa harnieri* (Murie)

*Antelope harnieri* Murie, Proc. Zool. Soc. London, p. 5, pl. 2, May 1867. (White Nile.)

*Kobus defassa breviceps* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 424, 1910. (Pembé, on the Nile between Dufilé and Matete, Lado Enclave.)

*Kobus defassa ladoensis* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 426, 1910. (Matete, on the Nile between Dufilé and Lado, Lado Enclave.)

*Kobus defassa griseotinctus* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 427, 1910. (Kerri, on the Nile near Kero, north of Lado, Lado Enclave.)

**SPECIMENS EXAMINED:** Three, all in BM, from: White Nile, about lat. 9° N., 1; Bahr Zeraf, Upper Nile, 1; Dinder River, 1.

**REMARKS:** The waterbuck probably occurs throughout the Nile drainage. It is usually found not far from permanent water.

*Adenota kob leucotis* (Lichtenstein and Peters)

*Antilope leucotis* Lichtenstein and Peters, Ber. K. Preuss. Akad. Wiss., Berlin (1853), p. 164, 1854. (Sobat River, Anglo-Egyptian Sudan.)

*Adenota kul* Heuglin, Nova Acta Acad. Caes. Leop.-Carol., Halle, vol. 30, No. 2, p. 12, 1863. (Plains of the Sobat.)

*Adenota wuil* Heuglin, Nova Acta Acad. Caes. Leop.-Carol., Halle, vol. 30, No. 2, p. 13, 1863. (Sobat Plains.)

*Adenota nigroscapulata* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 15, 1899. (Bahr-el-Gebel, between lat. 6° and 7° N.)

*Cobus vauhani* Lydekker, The Field (London), vol. 108, p. 693, Oct. 20, 1906. (Wau, lat. 7°30' N., long. 28°10' E.)

*Adenota kob notata* W. Rothschild, Ann. Mag. Nat. Hist., ser. 8, vol. 12, p. 575, December 1913. (Ahmed Aga, Bahr-el-Abiad.)

**SPECIMENS EXAMINED:** Twenty-two, from: Bahr-el-Ghazal, 2 (BM); Fan Ashir, 4 (BM); White Nile, 3 (BM); Lewelli, lat. 6° N., long. 33°40' E., 1 (BM); Awan, 1 (BM); Jebel Ahmed Aga, 2 (BM); Lokila, 1 (BM); Lake No, 4; Mouth of Bahr-el-Zeraf, 4.

**REMARKS:** The specimens from Jebel Ahmed Aga described by Rothschild (loc. cit.) as *A. k. notata* are not distinguishable from animals from the mouth of the Bahr-el-Zeraf and from Lake No. Unfortunately no specimens from the plains of the Sobat have been available, but specimens from the Bahr-el-Zeraf can be considered to represent this form. It thus appears that the names *nigroscapulata* and *notata* should fall as synonyms of *leucotis*.

The name *alurae* from Rhino Camp appears to be valid, since animals of like age are smaller and generally lighter in color than *leucotis*. It may be that the name *vauhani* from Wau, assigned as a synonym to *leucotis*, may actually be valid, in which case the name *alurae* would fall as a synonym to *vauhani*. No specimens of *vauhani* have been seen.

*Redunca bohor cottoni* (W. Rothschild)

*Cervicapra redunca cottoni* W. Rothschild, in Powell-Cotton, A sporting trip through Abyssinia (app. 3, mammals), p. 470, 1902. (Between Bahr-el-Zeraf and Bahr-el-Jebel.)

*Capra redunca donaldsoni* W. Rothschild, in Powell-Cotton, A sporting trip through Abyssinia (app. 3, mammals), p. 471, 1902. (East of Lado near Sudan-Uganda boundary, and western Somaliland.)

**SPECIMENS EXAMINED:** Ten, from: Gogriel, Bahr-el-Ghazal, 2 (BM); Kaka, 1 (BM); Dinder Valley, 1 (BM); 150 miles east of Lado, Mongalla Province, 2; 60 miles north of Nimule, 4.

REMARKS: The reedbuck is apparently rather widely distributed over the southern portion of the Sudan to about lat. 15° N. The favored habitat seems to be heavy reeds near watercourses.

*Hippotragus equinus bakeri* Heuglin

*Hippotragus bakeri* Heuglin, Nova Acta Acad. Caes. Leop.-Carol., Jena, vol. 30, No. 2, p. 16, 1863. (Between upper Atbara and Bahr-el-Salaam Rivers, near Abyssinian border.)

*Hippotragus equinus doggetti* de Beaux, Ann. Mus. Civ. Stor. Nat. Genova, ser. 3, vol. 9, p. 231, July 10, 1921. (Near Gondokoro.)

SPECIMENS EXAMINED: Thirteen, from: Meshra Zeraf, 3 (BM); Dinder River, 1 (BM); Dinder Valley, 1 (BM); Rejaf, 1; Gondokoro, 3; 60 miles north of Nimule, 2; Torit, 2.

REMARKS: The roan antelope apparently ranges over the southeast quarter of the Sudan.

The specimens from the Dinder River area are virtual topotypes of *bakeri*. I can discern no differences between these animals and ones from Gondokoro which are topotypes of *doggetti*. Therefore, I am referring all the roan antelopes from the south and southeastern Sudan to the earlier named *bakeri*.

*Oryx dammah* (Cretzschmar)

*Antelope dammah* Cretzschmar, in Rüppell, Atlas zu der Reise im nördlichen Afrika von Rüppell, pt. 1, Säugethiere, p. 22, 1826. ("Probably Kordofan," Haraza, eastern Anglo-Egyptian Sudan.)

*A[ntilope] tao* H. Smith, in Griffith, The animal kingdom . . . by the Baron Cuvier . . . , vol. 4, p. 189, vol. 5, p. 327, 1827. ("Some days journey's distance from the Bahr-el-Abiad.")

*Antilope algazella* Rüppell, Neue Wirbelthiere zu der Fauna von Abyssinien gehörig, Säugethiere, p. 26, 1835. (Plains of Nubia to Fayum, Egypt.)

SPECIMEN EXAMINED: One, in BM, from Sennaar.

REMARKS: The nomenclature of the scimitar oryx has been compounded in confusion. Ellerman and Morrison-Scott (1951, p. 385) regard Oken's names of 1816 to be untenable. With this, I agree. The next available name then, according to the above authors, is *Antilope tao* H. Smith, 1827, to replace *algazel* Oken, 1816. They further conclude that the northern African representatives of the oryx are not only congeneric but that they represent a monotypic species. I can find no disagreement with the latter conclusion. These authors, however, overlooked the earlier name *dammah* Cretzschmar, 1826, for the scimitar oryx, and since it is conceded that these animals are a monotypic species the name should thus stand as *Oryx dammah* Cretzschmar.

*Addax nasomaculatus* (Blainville)

*Cerophorus* (*Gazella*) or *A[ntilope]* *nasomaculata* Blainville, Bull. Sci. Soc. Philomatique, Paris, p. 75, 1816. (Probably Senegambia.)

*Antilope addax* Cretzschmar, in Rüppell, Atlas zu der Reise im nördlichen Afrika, von Rüppell, pt. 1, Säugethiere, p. 19, pl. 7, 1826. (Desert south of Ambukol to the Haraza Oasis.)

SPECIMENS EXAMINED: Three, all in BM, from: Southwest of Dongola, 1; northwestern Kordofan, lat.  $16^{\circ}$  N., long.  $28^{\circ}$  E., 1; Meridi, 200 miles southwest of Dongola, 1.

REMARKS: It is quite apparent that Ellerman and Morrison-Scott (1951, p. 385) were correct in considering *addax* of Cretzschmar to be identical to Blainville's earlier *nasomaculatus*. I can see no differences between the Sudanese specimens and those from the Sahara.

*Damaliscus korrigum tiang* (Heuglin)

*Damaliscus tiang* Heuglin, Nova Acta Acad. Caes. Leop.-Carol., Halle, vol. 30, No. 2, p. 22, 1863. (Sobat Valley.)

*Damaliscus tiang-riel* Heuglin, Nova Acta Acad. Caes. Leop.-Carol., Halle, vol. 30, No. 2, p. 23, 1863. (Bahr-el-Abiad.)

*Damaliscus corrugum jonesi* Lydekker, The Field (London), vol. 110, p. 250, Aug. 10, 1907. (Kordofan.)

*Damaliscus floweri* Matschie, Jahrb. Inst. Jagdk. Neudamm, vol. 2, p. 168, 1913. (Near Sherif Harrabulla, between Karkoj and Roseires, Blue Nile.)

SPECIMENS EXAMINED: Ten, all in BM, from: between Tonga and Lake No. 1; Lokila, 1; White Nile, 2; Gogriel, Bahr-el-Ghazal, 1; Dinder River, 3; Faki-kowi, 200 miles south of Khartoum, 1; Hagach Merurya, Khor Gelegu, upper Dinder River, 1.

*Alcelaphus buselaphus lelwel* (Heuglin)

## FIGURE 10.c

*A[cronotus]* *lelwel* Heuglin, Reise in Nordost-Afrika, vol. 2, p. 124, 1877. (Req country, Jur and Kosarge Rivers. Type locality fixed as Jur River by Schwarz (1920, p. 907).)

SPECIMEN EXAMINED: One, from Rejaf.

REMARKS: Ruxton and Schwarz (1929, p. 577) list *niediecki* as a synonym of *lelwel*. The type locality of the former, however, lies within the geographic range ascribed to *tora*. It seems, therefore, that on purely geographic grounds *niediecki* should stand as a synonym of *tora*.

*Alcelaphus buselaphus roosevelti* (Heller)

## FIGURE 10.c

*Bubalis lelwel roosevelti* Heller, Smithsonian Misc. Coll., vol. 60, No. 8, p. 7, Nov. 2, 1912. (Gondokoro.)

SPECIMENS EXAMINED: Sixteen, from: Lokila, 1 (BM); Terehaima, Torit District, 1 (BM); Logh Afrok, Torit District, 1 (BM); between

*Assua River and Gondokoro*, 3 (BM); Torit, 1; Obbo, 1; *Gondokoro*, 6; 80 miles north of Nimule, 1; vicinity of Nimule, 1.

REMARKS: This hartebeest may well be the same as *tora* from farther north and east. Ruxton and Schwarz (1929, p. 577) comment that this subspecies may, however, be classed with *jacksoni* whose range lies to the south and east. Whichever way *roosevelti* may be allocated it is certainly not a well defined subspecies.

*Alcelaphus buselaphus tora* Gray

FIGURE 10,c

*Alcephalus* (sic) *tora* Gray, Nature (London), vol. 8, p. 364, Sept. 4, 1873. (Preliminary notice.)

*Alcelaphus tora* Gray, Ann. Mag. Nat. Hist., ser. 4, vol. 12, p. 341, October 1873. (Dembelas, Bogos country, Ethiopia.)

*Bubalis niediecki* Neumann, Sitzb. Ges. Naturf. Freunde, Berlin, p. 95, 1905. (Jamboland, Gelo River, upper Sobat River, Ethiopia.)

SPECIMENS EXAMINED: Two, both in BM, from Kurmuk District, Blue Nile.

REMARKS: See under *roosevelti* and *lelwel*.

*Alcelaphus buselaphus tschadensis* (Schwarz)

FIGURE 10,c

*Bubalis lelwel tschadensis* Schwarz, Ann. Mag. Nat. Hist., ser. 8, vol. 11, p. 11, February 1913. (Ketekma, east of Tschekna, Bagirmi, French Equatorial Africa.)

SPECIMENS EXAMINED: Three, all in BM, from Kulme, Wadi Aribo.

REMARKS: This subspecies is considered by Ruxton and Schwarz (1929, p. 572) to be a part of the *lelwel* section of the species. It is doubtful, in my opinion, that any of the so-called races here given as occurring in the Sudan will stand under critical examination, but rather will be shown to be synonymous with the older name *tora*.

Subfamily Antilopinae

*Ourebia ourebi aequatoria* Heller

*Ourebia montana aequatoria* Heller, Smithsonian Misc. Coll., vol. 60, No. 8, p. 12, Nov. 2, 1912. (Rhino Camp, Lado Enclave.)

*Ourebia ourebi ugandae* de Beaux, Ann. Mus. Civ. Stor. Nat. Genova, ser. 3, No. 9, p. 223, Mar. 31, 1921. (Near Gondokoro.)

SPECIMENS EXAMINED: Fifteen, from: Adamadi's Village, Bari Country, lat. 4°10' N., long. 31°40' E., 1 (BM); Mongalla Province, 80 miles north of lat. 4° N., 50 miles east of long. 32° E., 1 (BM); Nimule, 4; Torit, 5; Lokila, 3; 8½ miles north of Mongalla, 1 (BM).

REMARKS: The nomenclature of the oribis in the Sudan is indeed confused. The amount of variation in a series of *O. o. cottoni* from

the Guaso Ngishu Plateau, British East Africa, is quite striking. The color of the pelage ranges from a pale buff to a strong reddish cinnamon, yet the skulls appear to be quite uniform in their characteristics. The specimens from Nimule and Torit show this same amount of variation in color and the same degree of uniformity of cranial characters.

While no specimens have been seen from Gondokoro, specimens compared to the type of *aequatoria* from Nimule and Torit show no differences, and those specimens, in turn, compared to material from Mongalla Province show no dissimilarities. Therefore, I feel that the name *O. o. ugandae* should fall as a synonym of the earlier *aequatoria*.

***Ourebia ourebi montana* (Cretzschmar)**

*Antelope montana* Cretzschmar, in Rüppell, Atlas zu der Reise im nördlichen Afrika von Rüppell, pt. 1, Säugethiere, p. 11, pl. 3, 1826. (Fazogli Hills, Blue Nile.)

*Ant[elope] brevicaudata* Rüppell, Neue Wirbelthiere zu der Fauna von Abyssinien gehörig, Säugethiere, p. 25, 1835. (Sennaar.)

**SPECIMENS EXAMINED:** Thirteen, all in BM, from: Between Tonga and Lake No, 1; 100 miles northeast of Bor, 1; White Nile, about lat. 11° N., 2; 5 miles west of Rumbek, 1; Kamisa, Dinder River, 1; Upper Nile, 1; Kornook, 1; 18 miles southwest of Shambe, 1; 8 miles south of Tonga, 3; halfway between 1st and 2d resthouses on way to Meshra, 1.

**REMARKS:** In only a cursory examination of the ungulates of the Sudan, it is apparent that they all need a vast amount of work done on them. In *Ourebia*, particularly, there are many striking similarities between the subspecies. It may well be that when they are studied in more exacting detail *montana* will be found to be the name to be applied to all of the eastern and southern Sudanese oribis.

***Rhynchotragus guentheri smithii* (Thomas)**

*Madoqua guentheri smithii* Thomas, Proc. Zool. Soc. London (1900), p. 804, Apr. 1, 1901. (About 30 miles southeast of Lake Stephanie, Ethiopian Border.)

**SPECIMENS EXAMINED:** Twelve, from: Ikoto, 8; Torit, 3; Latuka Mountains, 1 (BM).

**REMARKS:** The long-snouted dikdiks are apparently found only in the extreme southeastern Sudan in open savanna country.

**Notes on *Gazella***

The genus *Gazella*, in the Sudan, is divided into two subgenera. The typical subgenus, *Gazella*, is distinguished by the following: Females bearing well developed horns; body size small or medium; and white of rump not intruding far into fawn color of body. The species

in the Sudan which are referable to this subgenus are *G. dorcas*, *G. leptoceros*, *G. rufifrons*, and *G. thompsonii*.

The second subgenus in the Sudan is *Nanger*. It is characterized by the following: Females with well developed horns; body size large; and white of rump extending rather far into fawn color of body. The species in the Sudan which are referable to this subgenus are *G. granti*, *G. soemmerringii*, and *G. dama*.

### Key to the species in the subgenus *Gazella*

- |   |                   |
|---|-------------------|
| 1. Flank band indistinct . . . . .                      | 2                 |
| Flank band black . . . . .                              | 3                 |
| 2. Horns usually lyrate . . . . .                       | <i>dorcas</i>     |
| Horns usually not lyrate . . . . .                      | <i>leptoceros</i> |
| 3. Nose spot absent; light face stripes buffy . . . . . | <i>rufifrons</i>  |
| Nose spot black; light face stripes white . . . . .     | <i>thompsonii</i> |

The species of the subgenus *Nanger* may be distinguished from one another by the length of the horns. In *granti*, the horns approximate 30 inches and lack any terminal hooking; *soemmerringii* has horns approximating 22 inches and the tips hook inward; in *dama* the horns approximate 13 inches and the tips hook forward and upward.

### *Gazella dorcas isabella* Gray

FIGURE 10,d

*Gazella isabella* Gray, Ann. Mag. Nat. Hist., ser. 1, vol. 18, p. 214, September 1846.

(Type locality fixed as Abyssinia by Blaine, 1913, p. 292.)

*Antilope dorcas*,  $\alpha$  *isidis* Sundevall, Kongl. Svenska Vet.-Akad. Handl., Stockholm (1845), p. 267, 1847. (Sennaar, Nubia, Egypt.)

SPECIMENS EXAMINED: Two, both in BM, from: Mashail, 1; Khor Hadbad, 1.

### *Gazella dorcas littoralis* Blaine

FIGURE 10,d

*Gazella littoralis* Blaine, Ann. Mag. Nat. Hist., ser. 8, vol. 11, p. 295, March 1913.

(Khorasot, Nubian Desert.)

SPECIMENS EXAMINED: Seventeen, from: Suakin, 3 (BM); 5 miles south of Suakin, 1 (BM); 12 miles south of Suakin, 1 (BM); Atrababai Hills, 1 (BM); Hafta, 1 (BM); Dongola, 2 (BM); Jebel Bawati, 8.

### *Gazella dorcas osiris* Blaine

FIGURE 10,d

*Gazella littoralis osiris* Blaine, Ann. Mag. Nat. Hist., ser. 8, vol. 11, p. 295, March 1913. (Nakheila, near junction of Atbara with the Nile.)

SPECIMENS EXAMINED: Ten, all in BM, from: Nakheila, 5; Omdurman, 1; near El Fasher, 1; Kordofan, 1; 10 miles northwest of El Fasher, 1; 10 miles east of El Fasher, 1.



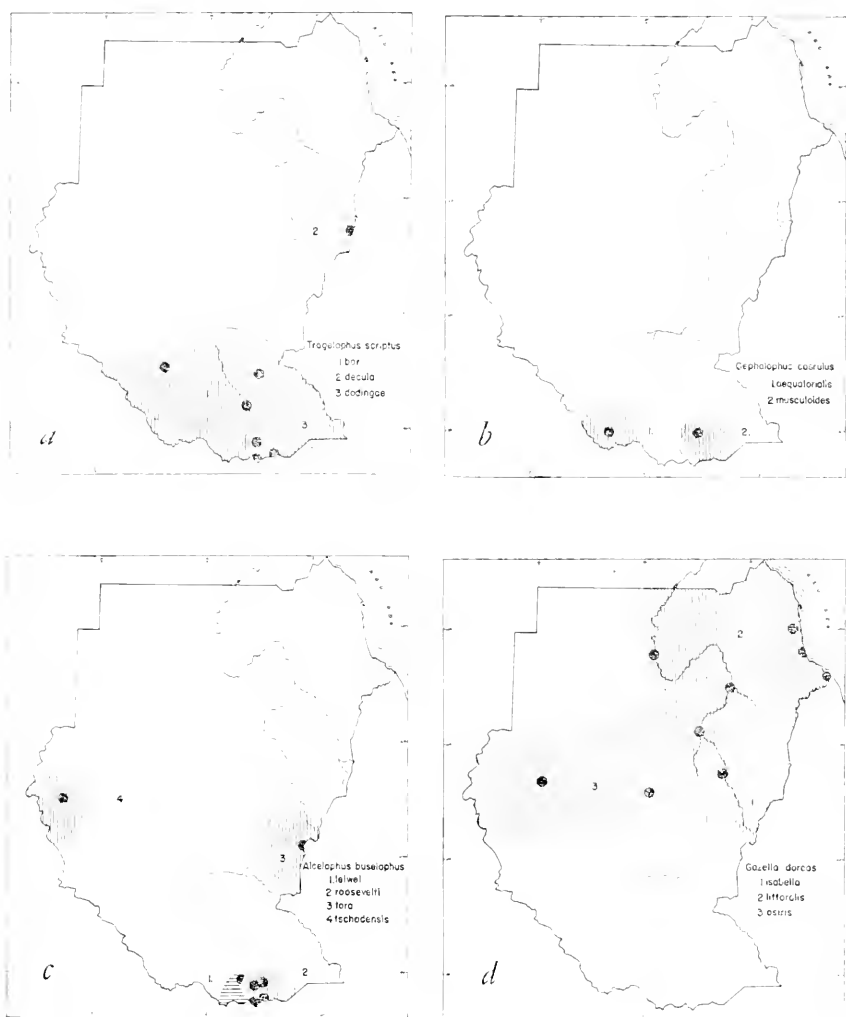


FIGURE 10.—Distribution of *Tragelaphus*, *Cephalophus*, *Alcelaphus*, and *Gazella* in the Anglo-Egyptian Sudan. (Scale: 1 inch=400 miles.)

***Gazella leptoceros leptoceros* (F. Cuvier)**

*Antilope leptoceros* F. Cuvier, in E. Geoffroy and F. Cuvier, *Histoire naturelle des mammifères*, vol. 7, pt. 72, p. 2, pls. 373, 374, August 1842. ("Typical locality apparently Sennaar," Lydekker and Blaine, vol. 3, p. 68. 1914.)

REMARKS: No specimens of this gazelle have been examined and it seems doubtful to me that this species occurs as far south as the Sudan. If it does occur, it will probably be found in the extreme northwest.

*Gazella rufifrons laevipes* (Sundevall)

*A[ntilope] laevipes* Sundevall, Kongl. Svenska Vet.-Akad. Handl., Stockholm (1845), p. 266, 1847. (Sennaar; Senegal.)

*Gazella salmi* Lorenz, Sitzb. K. Akad. Wiss. Wien, Math.-Nat., vol. 115, sec. 1, pt. 1, p. 21, January 1906. (Fashoda.)

SPECIMENS EXAMINED: Eight, all in BM, from: Jebel Ahmed Aga, 1; Mongalla, 1; Faki-Kowi, 300 miles south of Khartoum, 1; near Fashoda, 1; White Nile, about lat. 11° N., 1; Agageh, 2; Kaka, 1.

REMARKS: The red-fronted gazelle may be distinguished from the dorcas gazelle by means of its darker color, larger size, and pronounced black lateral stripe.

*Gazella thompsonii albonotatus* W. Rothschild

*Gazella albonotata* W. Rothschild, Nov. Zool., vol. 10, p. 480, Dec. 20, 1903. (East side of White Nile, 40 miles north of Kero or Kiri, Mongalla Province.)

SPECIMENS EXAMINED: Six, all in BM, from: Mugatta, Atbara River, 1; Ishaga, Setit River, 1; Mongalla, 2; Unigara, Atbara River, 1; 90 miles east of Lado, 1.

*Gazella dama ruficollis* (H. Smith)

*A[ntilope] ruficollis* H. Smith, in Griffith, The animal kingdom . . . by the Baron Cuvier, vol. 4, p. 205, 1827. ("Nubia".)

*Antilope addra* Bennett, Proc. Zool. Soc. London, p. 2, May 17, 1833. (Nubia and Kordofan.)

*A[ntilope] dama* var. *orientalis* Sundevall, Kongl. Svenska Vet.-Akad. Handl., Stockholm (1845), p. 266, 1847. (Sennaar.)

SPECIMENS EXAMINED: Three, all in BM, from: 25 miles inland from Omdurman, 1; Kordofan, 1; Sennaar, 1.

*Gazella granti brighti* Thomas

*Gazella granti brighti* Thomas, Proc. Zool. Soc. London (1900), p. 805, Apr. 1, 1901. (150 miles east of Lado, lat. 5°20' N., long. 34°5' E.)

SPECIMENS EXAMINED: Three, from: 12 miles north of Afmadu, Jubaland, 1 (BM); 150 miles east of Lado, 1 (BM); 160 miles east of Lado, 1.

*Gazella soemmerringii sibyllae* Matschie

*Gazella* (*Nanger*) *soemmerringii sibyllae* Matschie, Sitzb. Ges. Naturf. Freunde, Berlin, p. 261, 1912. (Singa, Blue Nile.)

SPECIMENS EXAMINED: Five, all in BM, from: Rahad River, 1; Nakheila, 1; 12 miles south of Suakin, 1; Dinder Valley, 1; 18 kilometers from Tokar toward Suakin, 1.

## Subfamily Caprinae

*Capra ibex nubiana* F. Cuvier

*Capra nubiana* F. Cuvier, in E. Geoffroy and F. Cuvier, *Histoire naturelle des mammifères*, vol. 6, pl. 397, p. 2, June 1825. (Nubia.)

SPECIMENS EXAMINED: Four, all in BM, from: Mashail, 1; Red sea Province, 3.

REMARKS: Ellerman and Morrison-Scott (1951, p. 407) treat the Nubian ibex as a subspecies of *Capra ibex*. This is certainly more realistic than the arrangement followed by Schwarz (1935) in which he classed these animals with *Capra hircus*.

## LIST OF NEW NAMES PROPOSED

(Page Numbers in Parentheses)

<i>Atelerix pruneri lowei</i> (453)	<i>Mastomys kulmei</i> (517)
<i>Elephantulus rufescens hoogstraali</i> (456)	<i>Mastomys natalensis agurensis</i> (520)
<i>Crocidura bicolor tephragaster</i> (458)	<i>Mastomys natalensis marrensis</i> (522)
<i>Crocidura hildegardeae phaios</i> (460)	<i>Praomys fumatus oweni</i> (525)
<i>Crocidura nyansae toritensis</i> (462)	<i>Praomys tullbergi sudanensis</i> (527)
<i>Crocidura turba tephra</i> (466)	<i>Mus bellus delamensis</i> (528)
<i>Poelagus marjorita oweni</i> (472)	<i>Acomys lowei</i> (536)
<i>Lepus capensis dinderus</i> (474)	<i>Steatomys thomasi</i> (541)
<i>Gerbillus gerbillus sudanensis</i> (488)	<i>Graphiurus murinus marrensis</i> (542)
<i>Grammomys macmillani erythropygus</i> (501)	<i>Cryptomys ochraceocinereus oweni</i> (548)
<i>Oenomys hyporanthus talangae</i> (505)	<i>Heterohyrax brucei hoogstraali</i> (564)
<i>Dasymys incomtus palustris</i> (506)	

## Gazeteer

Abu Fatima: 22°25' N., 36°26' E.	Berber: 18° N., 34° E.
Abu Heraz: 12°59' N., 29°58' E.; 14°30' N., 33°35' E.; 18°2' N., 33°58' E.; 19°4' N., 32°4' E.; 14°55' N., 33°5' E.	Bir el Girud (=Bir Girid): 22°26' N., 36°23' E.
Abu Ushar: 14°55' N., 33°5' E.	Bongo: 6°40' N., 29°40' E.
Abu Zabad: 145 km. southwest of El Obeid.	Bor: 6°10' N., 31°35' E.
Adamadi's Village: 4°10' N., 31°40' E.	Chak Chak: 8°40' N., 26°55' E.
Agageh Wells: 10° N., 29°12' E.	Char, Didinga Mts.: 4°8' N., 33°47' E.
Aggar Forest: 4°40' N., 29°47' E.	Delami: 11°50' N., 30°25' E.
Agur: 11°35' N., 30°28' E.	Dilling: 12°5' N., 29°40' E.
Akanda (see Ukanda).	Dongola: 19°13' N., 30°27' E.
Aradeiba: 12°25' N., 34°20' E.	Dorila Lakes: 12°55' N., 24°15' E.
Atbara: 17°40' N., 34° E.	Dud Majok (=Majak): 9°5' N., 27°51' E.; 9°13' N., 28°37' E.
Atra Rabai Hills (see Jebel Atraab).	Duem: 14° N., 32°20' E.
Awan: 6°6' N., 31°48' E.	Dugdug: 8°5' N., 28°34' E.
Ayod: 8°5' N., 31°25' E.	Duk: 90 miles northeast of Bor.
Badigeru Swamp: 20 miles east of Mongalla.	Duk Fagioil (=Duk Faiwil): 7°30' N., 31°30' E.
Bendele: 4°34' N., 28°23' E.	Eirerib (=Eireibab): 14°39' N., 33°24' E.
	El Fasher: 13°42' N., 25°20' E.

- El Garef: 12°3' N., 34°19' E.  
 El Kowa: 13°40' N., 32°30' E.  
 El Malha (see Jebel Meidob).  
 El Obeid: 13°12' N., 30°17' E.  
 Emogadung, Dongotona Mts.: 4°11' N., 33°11' E.  
 En Nahud (see Nahud).  
 Erkowit: 18°45' N., 34°15' E.  
 Eros: 4°7' N., 33°46' E.  
 Er Renk: 11°45' N., 32°50' E.  
 Faki-kowi: 200 miles south of Khar-toum.  
 Fashoda (see Kodok).  
 Fazogli: 11°20' N., 34°35' E.  
 Fort Berkeley: 4°40' N., 31°35' E.  
 Gallabat: 12°55' N., 36°10' E.  
 Gebel Auli: 15°12' N., 32°33' E.  
 Gebel Talodi: 10°36' N., 30°23' E.  
 Gedaref: 14°3' N., 35°25' E.  
 Gerazi: 13°38' N., 25°21' E.  
 Gilo: 4°2' N., 32°50' E.  
 Gogrial: 8°30' N., 28°3' E.  
 Gondokoro: 4°54' N., 31°40' E.  
 Goz Abu Gama (= Abu Gamal): 15°10' N., 36°26' E.  
 Habissa Wells: 15°35' N., 31°25' E.  
 Hagach Merurya (= Khor Gelegu): 12°33' N., 35°20' E.  
 Hamra: 14°5' N., 24°55' E.; 14°30' N., 31°55' E.  
 Haraza (see Jebel Haraza).  
 Ikoto: 4°6' N., 33°6' E.  
 Imela: 4°10' N., 32°41' E.  
 Imowa (= Iwowa, Didinga Mts.): 4°17' N., 33°42' E.  
 Imurok: 4°19' N., 32°24' E.  
 Ishaga, Setit River: 14°10' N., 36°15' E.  
 Issore, Imatong Mts.: 3°55' N., 32°48' E.  
 Jebel Ahmed Aga: 11°3' N., 32°40' E.  
 Jebel Ain: 12°40' N., 32°50' E.  
 Jebel Atraab: 18°8' N., 38°20' E.  
 Jebel Bawati: 19°55' N., 36°55' E.  
 Jebel Haraza: 15° N., 30°25' E.  
 Jebel Kadaro: 12°8' N., 30°15' E.  
 Jebel Marra: 12°45' N., to 13°30' N. and 24°15' E. to 24°45' E.  
 Jebel Meidob: 15°15' N., 28°30' E.  
 Jebel Um Durragh: 14°50' N., 30°12' E.  
 Juba: 4°50' N., 31°40' E.  
 Juga Juga: 15 miles east-northeast of El Fasher.  
 Kagula: 11°8' N., 30°20' E.  
 Kajo Kaji: 60 miles south of Rejaf.  
 Kaka: 10°35' N., 32°10' E.  
 Kamisa, Dinder River: 13°35' N., 34°5' E.  
 Katire: 4°2' N., 32°47' E.  
 Katta: 7°52' N., 21°53' E.  
 Katul Hills: 14°16' N., 29°25' E.  
 Kenisa: 6°50' N., 31°10' E.  
 Kerma: 19°35' N., 30°25' E.  
 Khartoum: 15°40' N., 32°35' E.  
 Khor Arbat: 19°45' N., 36°55' E.  
 Khorasot (= Khor Asot): 18°18' N., 36°10' E.  
 Khor Gitti: 7°40' N., 27°40' E.  
 Khor Gorman: 30 miles west of Rumbek.  
 Khor Hanoieit: 19°52' N., 37°11' E.  
 Khor Mog: 21°50' N., 36°22' E.  
 Kinyeti Valley, Imatong Mts.: 3°58' N., 32°54' E.  
 Kipia, Imatong Mts.: 3°57' N., 32°58' E.  
 Kit River: 4°30' N., 31°45' E.  
 Kitibol, Imatong Mts.: 4°2' N., 32°51' E.  
 Kodok: 9°53' N., 32°5' E.  
 Kornook (= Kurnuk): 12°45' N., 31°57' E.  
 Kulme, Wadi Aribo: 12°35' N., 23°40' E.  
 Kurra, northeastern Jebel Marra: 13°17' N., 24°30' E.  
 Labalwa: 4°26' N., 32°38' E.  
 Laboni, Imatong Mts.: 3°49' N., 32°46' E.  
 Lado: 5° N., 31°45' E.  
 Lafon: 5°2' N., 32°27' E.  
 Lake No: 9°25' N., 30°35' E.  
 Lalanga, Lofit Hills: 4°36' N., 32°54' E.  
 Latuka Mts.: 4°30' N., 32°40' E.  
 Lerua: 4° N., 32°34' E.  
 Letti Basin: 4°2' N., 32°34' E.  
 Lewelli: 6° N., 33°40' E.  
 Loa: 18 miles north of Nimule.  
 Loka: 60 miles southwest of Fort Berkeley, 4°15' N., 31° E.  
 Lokila: 4°40' N., 32°30' E.  
 Lokwi: 25 miles south of Torit.  
 Lomoling, Imatong Mts.: 4°7' N., 32°31' E.  
 Longairo: 20 miles east of Torit.  
 Loronyo: 4°38' N., 32°38' E.

- Lotti Forest, Imatong Mts.: 4°2' N., 32°33' E.  
 Mt. Baginzi: 4°40' N., 29°45' E.  
 Mt. Lotuke: 4°9' N., 33°48' E.  
 Madu: 80 miles northeast of El Fasher.  
 Magwe: 36 miles southwest of Torit.  
 Malakal: 9°30' N., 31°45' E.  
 Malek: 6°3' N., 31°42' E.  
 Malhab: 15°5' N., 26°7' E.  
 Maman: north of Kassala, 15°42' N., 36°25' E.  
 Medani: 14°20' N., 33°30' E.  
 Meridi: 4°55' N., 29°32' E.  
 Merowe: 18°28' N., 31°52' E.  
 Meshra Zeraf: 10°51' N., 32°30' E.  
 Moli: 30 miles north of Nimule.  
 Mongalla: 5°10' N., 31°50' E.  
 Moya: 7°48' N., 28°16' E.  
 Mugatta, Atbara River: 14°40' N., 35°55' E.  
 Mura, Lofit Hills: 4°48' N., 33°43' E.  
 Murukurun: 50 miles east of Torit.  
 Nagichot: 100 miles east of Torit.  
 Nahud: 11°45' N., 28°25' E.  
 Nakheila: 17°45' N., 34° E.  
 N'doruuna: 5° N., 27°30' E.  
 Ngaboli: 47 miles north of Torit.  
 Nimule: 3°36' N., 32°3' E.  
 Nubbaka(=Kubbaka), see Nabaqaya in El Obeid area: 12°47' N., 30°46' E.  
 Obbo: 4°2' N., 32°28' E.  
 Okaru: 4°29' N., 32°10' E.  
 Omdurman: 15°37' N., 32°30' E.  
 Opari: 50 miles southwest of Torit.  
 Palwar: 45 miles south of Torit.  
 Port Sudan: 19°35' N., 37°15' E.  
 Raffili: 6°52' N., 27°58' E.  
 Rejaf: 4°45' N., 31°37' E.  
 Roseires: 11°52' N., 34°28' E.  
 Rumbek: 6°45' N., 29°40' E.  
 Sabaluka: 16°20' N., 32°40' E.  
 Selima Oasis: 100 miles west of Wadi Halfa.  
 Sennaar: 13°35' N., 33°40' E.
- Shabluka Hills: 16°16' N., 32°44' E.  
 Shambe: 7°8' N., 30°52' E.  
 Shendi: 16°40' N., 33°27' E.  
 Shereik: 18°45' N., 33°36' E.  
 Shilluk Islands: 9°40' N., 31°30' E.  
 Shubhikra(=Shubeika, north of Omdurman): 15°12' N., 33°46' E.  
 Singa: 13°12' N., 33°55' E.  
 Sinkat: 18°47' N., 36°50' E.  
 Soba: 15°30' N., 32°40' E.  
 Suakin: 19°5' N., 37°22' E.  
 Sue River: 4°45' N., 28°45' E.  
 Sunnat: 4°16' N., 32°49' E.  
 Tagbo Hills: 14°45' N., 25°50' E.  
 Talanga Forest, Imatong Mts.: 4° N., 32°44' E.  
 Talodi: 10°40' N., 30°25' E.  
 Tembura: 5°40' N., 27°30' E.  
 Terangole: 20 miles east of Torit.  
 Tina Wells: 13°28' N., 24°46' E.  
 Tobbo(=Taba): 10°57' N., 29°32' E.  
 Tokar: 18°25' N., 37°45' E.  
 Tonga: 9°30' N., 31°3' E.  
 Torit: 4°24' N., 32°34' E.  
 Ukanda(=Fort Ukanda): 7°10' N., 25°42' E.  
 Uma: 50 miles north of Nimule.  
 Umm Keddada: 13°35' N., 26°40' E.; 9°57' N., 30°30' E.  
 Um Ramad: 12°58' N., 30°2' E.  
 Uvolo(=Mvolo): 6°4' N., 29°56' E.  
 Un Dona(=Umm Doma): 20°34' N., 34°16' E.  
 Wad Ferow(=Wadi Hafero): 15°24' N., 26° 12' E.  
 Wadferua: 19°30' N., 33°24' E.  
 Wadi Alagi: 22° N., 35° E.  
 Wadi Aribo(see Kulme).  
 Wadi Hafta: 17°43' N., 37°36' E.  
 Wadi Medani: 10°4' N., 30°40' E.  
 Wau, Jur River: 7°40' N., 28°2' E.  
 Yambio: 4°33' N., 28°22' E.  
 Yei: 4°7' N., 30°40' E.  
 Zalingei: 12°57' N., 23°29' E.

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